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Final report

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2 Executive summary

The project “Improving research and development of Myanmar’s inland and coastal Fisheries” (MYFish) aimed to strengthen research and development capacity in Myanmar’s capture and culture fisheries to facilitate co-management and to develop small-scale aquaculture (SSA) in the Ayeyarwady Delta (AD) and Central Dry Zone (CDZ). MYFish has been a timely project for the Department of Fisheries (DoF) coinciding with the political and rural reforms of the rural sector initiated in 2011 by the new civilian government. The project has promoted new understandings of the fishery sector and DoF are increasingly applying research for development and management that is stimulating new policy directions in rural aquaculture and fisheries management.

MYFish has demonstrated increases in production by 40% and doubling of gross income through SSA and producer networks, and has improved R&D capabilities resulting in new knowledge and learning. The project has benefited from the close partnership developed between WorldFish and DoF and embedding the project within the institution of DoF. The partnership has engaged technical staff, researchers and policy makers in research and extended these interactions to NGOs, universities, private sector, fishers and producers.

MYFish is the first intervention in fisheries to allocate funds directly to DoF and this has strengthened the institutional capacity of DoF to carry-out research projects. The project developed two successful research modalities that facilitated and strengthened research capabilities within DoF and sector. The first is the Activity Working Groups (AWGs) that are research groups set-up within DoF. The second is the Fisheries Research and Development and Network (FRDN), a science network that brought together DoF with other sector partners to share knowledge and identify and implement fisheries research.

The FRDN has helped place DoF at the centre of the learning process in Myanmar fisheries and encouraged research collaborations with universities, private sector and NGOs. The FRDN has funded over 20 research projects and promoted interactions between members through the hosting of annual symposia. DoF has established a publishing portfolio linked to an online digital library called the Fishery Information Centre (FIC) (dof.myanmar.fic@gmail.com). The FIC is the largest repository of Myanmar information on fisheries and is providing access to previously unseen data.

MYFish piloted SSA with research methodologies that use a combination of on-station trials and participatory ‘farmer-field school’ approaches. MYFish has introduced and developed a gender strategy that has mainstreamed gender in the research process. The project has impacted on DoF’s discourse on research and has shifted the perspective of fisheries from one centred on productivity and revenue rising to include social elements to benefit fishing communities and rural households.

The scaling of proven technologies has also been an important development goal for the project, which WorldFish and DoF have pursued through additional funding levered from the Livelihood and Food Security Trust (LIFT) and European Union (EU). In total $AUD8.5 has been raised to scale MYFish small scale aquaculture (SSA) technologies and techniques to 15,000 rural households by 2019 to benefit 60,000 people, which is worth AUD$5.9 million annually in fish production

The demand from the Ministry and DoF for continued interaction with MYFish has created a long-term program of support for fisheries research. WorldFish has invested in developing a country program office and a 10-year agreement signed with the Ministry in 2015. This has formalized many of the modalities developed under MYFish. Policy support is maintained through regular communications and meetings with DoF and Ministry. This has helped to facilitate policy discussions including policy advisories for the new National League of Democracy (NLD) Government. MYFish science networks and partnerships will increasingly play an important role in building trust and stimulating change particularly as the number of investors grow and demand on fisheries increase.

3 Background

The Myanmar fisheries sector is vital for national food security, income generation and export earnings and is experiencing increasing demands to deliver food and incomes for the growing domestic population of 52 million. Fisheries and aquaculture are an important part of the primary production and represented 8% of the country's GDP in 2014-2015[1]. During this period, fisheries and aquaculture produced 5.3 million tonnes of fish and exported over 338,000 tonnes valued at USD 482 million (ibid). In 2014, fisheries directly employed more than 3 million people. Seventy per cent of the fish harvested is consumed nationally (21–46 kg/person/year)[2], making fish and fish products second only to rice in importance in the diet.

Despite the importance of the fisheries sector to national food security, income generation and export earnings, fishery development and management remains weak across the sector. Successive governments have failed to recognize the importance of fisheries to the rural economy with policies, laws and institutions focused primarily on revenue capture and meeting centrally planned production targets. DoF reported increasing fish production from 0.83 million tons in 1994 to 5.05 million tons in 2013-2014, figures that probably reflect centrally planned targets rather than actual production, as evidenced from recent stock assessments and consumption surveys[3] [4].

The fisheries sector in Myanmar faces several challenges to its resource base. In many areas, unprecedented pressures are now being exerted on fish stocks and the natural resources that support production and there are concerns that current fish production, consumption and export earnings levels may become difficult to maintain. In the AD, anecdotal information from fisher communities suggests that fish catches have yet to return to pre-Cyclone Nargis, (2008) levels.

Inland capture fisheries are a major contributor to the fisheries sector and contributes almost 70% of the fish consumed in the national diet. According to national statistics, inland fisheries generated 1.3 million metric tons in 2013—a full 28% of total fish production. Management of inland fish resources remains constrained by the lack of comprehensive and reliable information on inland fisheries. Fish production is not evenly distributed throughout the country, with some areas, (e.g. Ayeyarwady Delta - AD), having a considerable fish surplus whilst others (e.g. Central Dry Zone - CDZ) suffering from an acute deficit and importing fish products from other parts of the country. Increasingly, fish production from reservoirs is being enhanced through the stocking of fingerlings although the contribution to food security is unclear.

Aquaculture has been growing quickly in Myanmar, at a rate of around 9% per year since 2004, and contributes 21% of the fish consumed nationally. In 2010, total production was estimated at 860,000 tonnes, (22% of total fisheries production). The bulk of this production is by large-scale producers and destined for export. One cultured fish species dominates Myanmar's fish exports; the Indian major carp, Rohu, (*Labeo rohita*). This single species (rohu), accounts for around 70% of the fish produced from aquaculture in Myanmar. This fish is exported in large quantities to other S&SE Asian countries as well as to the Middle East, (Kuwait, Saudi Arabia and U.A.E). Shrimp, a high value crop grown mainly for export, contributes just 5.6% of production. Aquaculture in Myanmar has become overly dependent on limited number of species and the lack of diversification is seen as a constraint to further growth of the aquaculture sector. Aquaculture is very

[1] *DoF statistics 2014-2015*

[2] *Variance in average consumption rate reflects the limited research data are available on the rates, the different patterns of fish consumption in Myanmar and different methods used to calculate national consumption rates*

[3] *Belton B., Hein A., Htoo K., Kham L.S., Nischan U., Reardon T., & Boughton D. (2015). Aquaculture in Transition: Value Chain Transformation, Fish and Food Security in Myanmar (No. 230981). Michigan State University, Department of Agricultural, Food, and Resource Economics.*

[4] *IMR (2014). Cruise Report "Dr. Fridtjof Nansen". Myanmar. Ecosystem Survey. 13 November – 17 December 2013. Final Draft*

concentrated geographically, with 90% of inland fish ponds located in the AD, close to Yangon. Farming fish generates average profits five to ten times higher than rice and other agricultural crops, and more than twice as much employment per acre as paddy farming.

Myanmar is unusual in the SE Asia region as not having an established small-scale aquaculture (SSA) sector, offering the opportunity for poorer farming households to diversify livelihoods and meet food security needs. With a growing population, (2012 estimate 1.1% per annum) and increasing pressure on capture fisheries, it is important that SSA emerges as an alternative to harvesting fish from the wild. In order for this to happen, technologies that are suitable for the various agro-ecological zones and cultural preferences of Myanmar's diverse people, need to be piloted and where successful, extended. The establishment of viable SSA is a major thrust of the MYFish project.

The international development community and local NGOs have worked with the Myanmar Government on a number of projects aimed at strengthening the fisheries sector, particularly in the AD, in the wake of Cyclone Nargis in 2008. A number of localised fisheries studies have been undertaken and projects focused on nutrition, livelihoods, networks, small-scale aquaculture and fisheries co-management implemented. Attention has turned to the CDZ in recognition of the severe food insecurity situation existing in this region. Building on the successes of these initiatives is an important strategy for MYFish, particularly the piloting of aquaculture suitable for rural households and better understanding the potential for co management in capture fisheries in the AD and CDZ.

Organisations and institutions working in fisheries development in Myanmar face three significant constraints: the lack of a comprehensive and reliable information base on fisheries; the proven suitability of new management approaches and technologies; and limited technical capacity to implement fishery projects. MYFish has been designed to address each of these constraints to build an information base on Myanmar fisheries, to identify and test new technologies, and to build research, development and extension (R,D&E) capacity within DoF and across the sector. By doing so MYFish is supporting government, NGOs, universities and private sector work in concert for the development of the sector.

Fisheries R,D&E have not been regarded as an investment priority for the government. However, the changing political landscape in Myanmar is likely to have consequences for Government institutions like the DoF, which will be asked to provide services that, at present they have limited capacity, experience and resources to do. MYFish is providing support to DoF in this role transition, which is greatly enhanced by embedding the project within the institutional structure of DoF enabling the project to promote new understandings of the fishery sector and to stimulate new policy directions in rural aquaculture and fisheries management.

In recent years, effective NGO networks such as the Food Security Working Group (FSWG) with over 100 members have been established to facilitate the exchange of information and dialogue on social development issues. The presence of an international institution, such as WorldFish, dedicated to working in partnership with Government departments, private sector, universities and NGOs, on fisheries research and development in Myanmar can greatly assist the focus and coordination of efforts to find innovative, sustainable and equitable solutions to the challenges facing Myanmar's fisheries sector.

4 Objectives

The aim of the project was to improve the capacity for management of Myanmar's inland capture and culture fisheries and facilitate the emergence of co management of fisheries and small-scale aquaculture as cornerstones of rural food security and livelihoods.

The project addressed a range of key research questions covering technical, socio-economic, environmental and institutional issues through the objectives. The research questions were:

1. What are the main characteristics of the various fisheries and aquaculture production systems in the two regions, how diverse and productive are they and what livelihoods and marketing chains do they support?
2. How sustainable are the current fish exploitation levels and what factors (environmental, socio-economic, cultural, institutional) may be constraining production in the two regions?
3. How important are small-scale fisheries and aquaculture to rural food security, especially amongst women and children in poorer communities? Could the importance of fisheries be increased?
4. Could a move towards co-management of inland & coastal fisheries contribute to greater sustainability, improved management and improved equity of benefits? If so, what would be the legal and institutional implications of a move from private licensed & leasehold fisheries to co-management fisheries systems?
5. How can fishing families of the Ayeyarwady Delta (AD) diversify and improve livelihoods through involvement in small-scale aquaculture, what systems would be most appropriate and what would be the contribution to food security?
6. Which areas of the Central Dry Zone (CDZ) have potential for small-scale aquaculture and/or fisheries and what management systems are appropriate for these conditions?

Objectives

There are three specific objectives (with approximate relative investment given in parentheses). These were:

Objective 1: To characterise the fisheries sector in the Ayeyarwady Delta and to assess the scope for fisheries development in the Central Dry Zone (30%).

1.1 Compile existing information and databases held by the DoF and other departments and organisations, on the Ayeyarwady Delta (AD) and the Central Dry Zone (CDZ)

1.2 Complete a multi-disciplinary scoping exercise for AD, involving DoF and other stakeholders including socio-economic specialists using CRP AAS participatory diagnostic methods

1.3 Prepare a national symposium on '*Fisheries of the Ayeyarwady Delta'* to identify key themes and issues and to develop frameworks for a characterisation study for AD.

1.4 Design and implement studies for the characterisation of AD that centre on the collection and analysis of baseline and time-series information

1.5 Summarise findings from the AD study into a series of technical publications, policy recommendations, and datasets

1.6 Complete a multi-disciplinary scoping exercise for CDZ, involving DoF and other stakeholders using CRP AAS participatory diagnostic methods

1.7 Prepare a symposium on the '*Potential for fisheries in the Central Dry Zone'* to identify key themes, areas and develop frameworks for the assessment study.

1.8 Design and implementing studies that describe the natural resources with fisheries potential as well as social, cultural and economic characteristics of CDZ.

1.9 Summarise the findings from the CDZ study into a series of technical publications, policy recommendations, and datasets

Objective 2: To identify, test and then demonstrate new approaches to increase productivity, efficiency, sustainability and equity in fisheries production systems in the Ayeyarwady Delta and the Central Dry Zone (40%).

2.1 Identify priorities for pilot interventions and research based on the AD fisheries characterisation study and the CDZ potentials study.

2.2 Design a set of specific pilot and research studies for DoF R&D and township implementation, and selecting themes for R&D projects through the FRDN mini-research fund.

2.3 Establish basic research study protocols, Standard Operating Procedures (SOP) and reporting formats for organisations collaborating with the project

2.4 Implement pilot and demonstration interventions and comparative trials to examine the suitability of novel production and management systems.

2.5 Support the DoF in producing a periodic newsletter and hosting 'Fisheries Research & Development Annual Meetings'

Objective 3: To strengthen the capacity of Government, private sector and non-government organisations to carry out appropriate research & development for the fisheries sector (30%).

3.1 Establish the Fishery Research & Development Network comprised of WorldFish, DoF, FSWG, Yangon University and MFF;

3.2 Establish activity working groups within the DoF on Capture Fisheries and Aquaculture, that will receive training and capacity building through joint implementation of the project's research, extension, field trials, and monitoring and evaluation under Objectives 1 and 2 with WorldFish experts;

3.3 Set up a managed research funding system through the FRDN and train the designated administrator in ACIAR accounting requirements and procedures.

3.4 Train key individuals in DoF and FRDN in field research topic identification, design, implementation, protocols, data analysis and management, and reporting.

5 Methodology

5.1.1 Research approach

Project embedded with DoF

MYFish applied a highly participatory approach to research, development and extension (R,D&E). The project was embedded within the Department of Fisheries (DoF) both in terms of physical presence and personnel. The project office was housed within DoF's Regional Fishery Office in Yangon and this provided daily interactions between DoF and WorldFish staff. A total of 6 part-time and 5 full-time staff from DoF were formally attached to the project with shared office space to conduct and implement research projects with technical backstopping provided from WorldFish scientists.

The research approach meant that R,D&E were carried out 'in situ' from within the institutional structure of the Research and Development Division of DoF. The timing of the project also benefited from and capitalized on the changing, more open, institutional environment within DoF. This was encouraged by the new reformist Government of President Thein Sein (2011-16) that wanted to target poverty reduction by increasing production and incomes for rural producers and households. In conjunction, administrative changes to the 2008 constitution decentralized and deconcentrated responsibility for the rural sector to regional and state governments. Regional governments could make their own laws for a number of commodities including fisheries and this provided additional opportunities to reduce poverty. DoF showed a willingness to apply new methods and approaches to fisheries R&D that could contribute to the reform process and discussions with senior government officials were candid and honest about how MYFish could help deliver the reforms in the fishery sector. (see project timeline Figure 1).

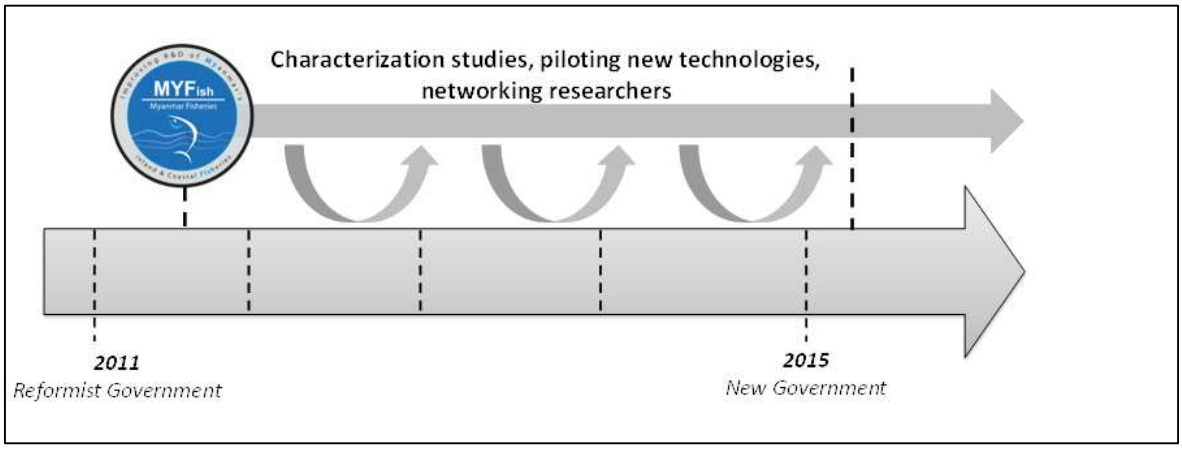

Figure 1: Project time line with changes of government

Research modality 1 - Activity Working Groups

Two research modalities were developed to facilitate R&D. The first modality was research groups set-up within DoF that were led by staff with technical experience in aquaculture and capture fisheries and these were called activity working groups (AWGs). Project funds were allocated to DoF to plan and undertake research activities that were applied through the AWGs. The AWGs aimed to re-focus efforts on research and on apply research methods to generate knowledge and data on the sector that were linked to fisheries development. Prior to this, there were very limited funds, facilities and capacities to do fisheries research and any research that was carried out lacked rigour and was not linked to sector development practices or outcomes. The AWG approach proved effective in building the capacity of researchers within DoF, and increasing their ownership of research outputs. It has helped DoF take a leading role in R&D in the sector in accordance with their mandate.

Research modality 2 – Fisheries Research and Development Network

The second research modality was called the Fisheries Research and Development and Network (FRDN). This was an informal network that brought together the DoF with other sector partners including Universities, private sector and NGOs to share knowledge and to identify research priorities. R&D capacities were strengthened within the FRDN through a series of mini-research grant projects. FRDN members had to submit proposals for funding and received assistance in methodology formulation, research implementation and quality control. The FRDN has supported over 20 research projects and has helped to promote cooperative research between the government, academic institutes, NGOs and private sector that previously did not exist. It has generated new knowledge on the sector and created a platform for policy debate facilitated through annual symposia where research findings have been presented and discussed amongst peers with government. It has also created links with international research institutions to support research and bring in expertise from outside of the country.

Geographic focus

MYFish focussed on two regions; the Ayeyarwady Delta (AD) and the Central Dry Zone (CDZ) (see Figure 2). Selection of the scoping areas and pilot sites was determined in consultation with government. These two regions vary considerably in their ecology and fish production potential. The diverse agro-ecological zones offered distinct livelihood and food security opportunities and challenges to small-scale fish producers. The Ayeyarwady Delta is by and large a fish surplus area with anecdotal information suggesting that fish production in recent years is in decline. The CDZ by contrast is a fish deficit area where fish production faces technical and cultural constraints.

Figure 2. Map of Myanmar highlighting project areas

Capacity development

All project activities incorporated capacity building using a combination of formal instruction and design, on-the-job training and learning-by-doing. The research process (see Figure 3 below) was developed to build awareness and understanding of the steps involved in research. The process was used to identify how a particularly project activity was contributing to the research. Prior to this, research was principally a data collection and reporting exercise determined by government. It had not been presented or used as a systematic process for identifying and solving problems defined by research questions. The research process was also used to promote policy development and illustrating to DoF staff how research can be used to provide evidence for policies.

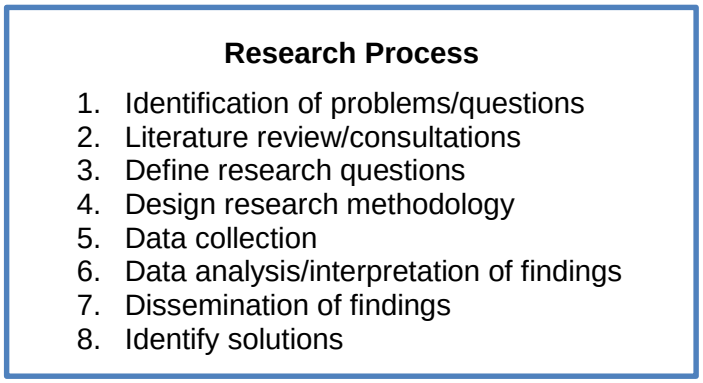

Figure 3: Steps in the research process

To further the capacity development approach, each of the research modalities (AWGs and the FRDN) were designed to strengthen the institutional capacity of DoF to undertake research, to engage stakeholders, and to build sector capacity in the research process. Cross cutting issues such as gender, climate change and resilience were introduced to the AWGs during the initial scoping and diagnostics and for the FRDN in the proposal preparation phase so that the pilot research projects selected considered cross cutting issues into the research design.

5.1.2 Objective 1: To characterise the fisheries sector in the Ayeyarwady Delta and to assess the scope for fisheries development in the Central Dry Zone

The methodologies applied to the characterisation studies for the AD and assessing the scope for fishery development in the CDZ involved four sequential phases: (1) scoping and diagnostics of the AD and CDZ; (2) consultation and prioritising research interventions through national symposia, meetings and seminars; (3) designing characterisation studies to be implemented through the AWGs or the FRDN; and (4) synthesising results to identify pilot projects for implementation under objective two.

Scoping and diagnostics

Preparation of the scoping surveys and diagnostics involved the compilation of existing information and databases held by the DoF and other departments. Although there was limited capacity within DoF for data storage and mapping there were organisations that were able to provide support during this initial stage to collate fishery data. A key organisation was the Myanmar Information Management Unit (MIMU) that provided services to UN agencies and also offered Geographic Information System (GIS) mapping courses for national institutes. The project initiated data sharing with MIMU on all project activities and these were geo-referenced through village post-codes they could be digitally stored and mapped. Prior to this collaboration, MIMU did not have any fishery data and base maps of the aquatic resources were added to MIMU's repository. During the scoping phase DoF started to collate data spread across the various departments and mainly held

in hard copy format. These were scanned and stored digitally to build a database and reference maps of the townships and fishing areas with summary profiles.

Mapping included ecological zoning where data was available to help frame the research. In the AD three ecological zones were defined based on the reach of saline water intrusion: coastal saline (coastal front); riverine brackish (estuarine zone); and inland freshwater (floodplain zone) (See Figures 4 and 5). The CDZ has a wider diversity of agro-ecological systems determined by availability of water and this ranges from upland areas with limited and irregular access to water to irrigated lowlands where most of the aquaculture production takes place.

Figure 4. Ecological zones in the Ayeyarwady Delta in relation to salinity. Source: Google map image adapted from Johnstone et al. 2012.

Figure 5. Google Earth view of the main landscape forms in the Ayeyarwady Delta. Adapted from Johnstone et al. 2012.

The scoping surveys were carried out in November 2012 in the AD and for the CDZ in July 2013. The surveys involved multi-disciplinary teams consisting of natural and social scientists from WorldFish, national fishery and aquaculture specialists from DoF, and experts from the universities, district level staff from DoF, private sector operators from Myanmar Fishery Federation (MFF), and local NGOs. Six research themes were used to frame the scoping and diagnostic surveys and applied AAS diagnostic tools (see figure 6). In the villages visited during the scoping, meetings were held with groups of fishers, producers, men and women, to facilitate participatory rural appraisal (PRA) tools including timeline, institutional and resource mapping. These tools were facilitated by DoF staff after training and under the supervision of WorldFish scientists.

1. Fishery and support ecosystem resources
2. Production systems - aquaculture
3. Value Chains & Markets
4. Poverty, Vulnerability and Gender Equity
5. Institutions and governance
6. Extension and knowledge management

Figure 6: Research themes used to frame the scoping

The diagnostic exercises aimed to address steps 1 to 4 of the research process and to engage DoF and sector partners in identifying research problems, questions and priorities. Methods such as problem tree analysis and stakeholder analysis were used to identify the potential research priorities and the data collection methods. The diagnostic phase also identified potential project sites and beneficiaries for characterisation and the pilots. The knowledge-gaps, research priorities and researchable projects identified during the scoping and diagnostics phases under objective one are listed in Appendix 1.

Consultation and prioritising research interventions

After each scoping and diagnostic survey the project held meetings and seminars with project staff and prepared a national symposium workshop. For the AD, this was held in Yangon in March 2013 and for the CDZ in December 2013 in Mandalay. The symposia provided a platform for the project to present the findings from the scoping so these could be verified and discussed. The symposia were also designed to enable different researchers and practitioners to present their own research findings and projects. This provided important context and a unique dialogue between the government and key partners working within the sector. The AD and CDZ symposia were attended by over 60 participants each with presentations made by over 20 local and international researchers on current research interests in fisheries and aquaculture in Myanmar. The symposia were designed so that DoF, sector partners and stakeholders could identify the main development challenges and opportunities facing fisheries and aquaculture in the AD and CDZ, and to prioritise the researchable projects. The scoping reports and symposia proceedings were translated into Burmese language and published by DoF.

Designing characterisation studies

The studies selected for the characterization of the AD fisheries and assessing the scope for fishery development in the CDZ are listed on Table 1 below and were applied via both the AWG and the FRDN research modalities. More studies were carried out in the AD compared to the CDZ reflecting the higher concentration of fishery related activities. Research undertaken by the AWGs and supported directly by WorldFish scientist tended to be larger in scale, more in-depth and applied complex methodologies involving formal trainings. Methodologies included compiling database, and designing and testing social and ecological surveys. The FRDN studies were smaller in scope, short-term studies that aimed to provide additional baseline information. Technical backstopping was provided by WorldFish scientists at different stages of the FRDN mini-research study process and

notably when assessing the proposal, reviewing methodologies, during the analysis, and technical inputs to the reports. Feedback was provided at key stages in the research process and linked to funding under the mini-research grant. If the field methodology was satisfactory than the agreement funds would be released to undertake the survey.

Synthesising results

Data compilations included building a database on licensed SSA households registered with DoF and combining this with NGO data on SSA households that had received funding support for aquaculture development after Cyclone Nargis. Data was also compiled on the locations and characteristics of inland fishery leaseholds and tender-lot sites in the AD and CDZ. Surveys methods included ecological and fish diversity surveys using digital tablets to store data and this method was used to assess the distribution of commercially important fish along a 1,000km stretch of the Ayeyarwady River. Socio-economic surveys included household (HH) surveys of over 1,000 HH to assess the livelihoods characteristics of producers and this also involved focus group discussions (FDGs) to assess institutional factors and community social cohesion. DoF were also exposed to key informant interviews techniques for in depth semi-structured interviews. Where specialist technical skills needed to be strengthened, training was providing by other research bodes such as FishBase in the Philippines that provided training over a 2-year period to assist with fish identification and the uploading data onto FishBase.

Research protocols were developed for each of the AWG studies (i.e. SSA survey, Hilsa assessment) and ethical concerns were discussed and integrated. Data analysis was either done externally or by WorldFish scientists with group discussions with DoF research staff used to interpret the findings. The write up of the research was facilitated through an initial drafting of the study findings by WorldFish scientists that providing a structure that was reviewed by DoF staff with requests for additional data and interpretations.

The characterisation studies were designed to be carried out during the initial half of the project. Following the first project reference committee meeting in December 2013 it was recommended that the characterisation studies would continue throughout the project period to continue gathering data and generating new information on the sector.

Table 1: Summary of characterisation studies - Ayeyarwady Delta and Central dry zone

Research theme	Characterization studies	
	Ayeyarwady Delta	**Central dry zone**
Aquaculture	1. Small-scale aquaculture survey- analysis of outcomes from existing small-scale aquaculture interventions, and identification of suitable technologies (AWG)	
	1. Trial of Green Water Hatchery – testing techniques to improved survival rates of the fresh water prawn *M. Rosenbergii* (MFF Yangon - FRDN) 2. Small-scale Responsible Aquaculture in Mangroves Forest area, Labutta (MFF Labutta - FRDN)	2. Research of the fish culture with net cages in reservoirs and rivers (DoF Magway - FRDN) 3. Effect of different food types on growth rate in a polyculture production system (DoF Sagaing- FRDN) 4. Aquaculture and livelihood in CDZ of Myanmar (NAG - FRDN)
Capture fishery	5. Distribution, migrations and breeding of Hilsa (*Tenualosa ilisha*) in the Ayeyarwady system in Myanmar (AWG)	
	6. Characterization of leasable fisheries in the Ayeyarwady Delta (AWG) 7. Assessment of fish resource availability and income generating activities of fishers in Maubin Township, Ayeyarwady Delta (Maubin University - FRDN) 8. Rapid assessment of river fisheries with stakeholder participation (Yatanarpon University - FRDN) 9. Investigation of fish resources and assessment of different fishing gears activities in various leasable fisheries and Chindwin River (Monywa University - FRDN)	6. Status of fisheries resources and culture-based capture fisheries management at Sedawgyi Dam (Mandalay University - FRDN)
Markets and value chains	7. Investigation on the value chain of Hilsa and other high market value fishes in the Ayeyarwady Delta Region (Dagon University- FRDN) 8. Characterization of market price and value chain of fisheries products in the Ayeyarwady Delta (Dagon University - FRDN) 9. Mud crab market and value-chain study in the Ayeyarwady Delta (DoF - FRDN) 10. Fishery value chain assessment in CDZ (MBBD - FRDN)	11. Value chain analysis of Rohu in Shwebo (MFF Shwebo - FRDN)
Food security and nutrition	12. Assessment of the role of fish for food and nutrition security in Myanmar for small-scale aquaculture producer households in the Ayeyarwady Delta and Central Dry Zone (AWG)	
	13. Nutrition and consumption patterns of fisher households in the community of Twantay Townships of Ayeyarwady Delta (Yangon University - FRDN)	
Livelihoods	14. Livelihood assessment on the Hilsa fisher families in the Ayeyarwady Delta (MMRD - FRDN) 15. Livelihood characteristics of fisher communities at different geographical areas in the Ayeyarwady Delta (Hinthada University FRDN) 16. An analytical pilot study to reduce poverty from Small Scale fishermen (MCU - FRDN)	17. Study of aquaculture and livelihood in CDZ (MFF Shwebo - FRDN)

5.1.3 Objective 2: To identify, test and then demonstrate new approaches to increase productivity, efficiency, sustainability and equity in fisheries production systems in the Ayeyarwady Delta and the Central Dry Zone

The identification, testing and demonstration of new technologies and techniques were applied primarily to the development of small-scale aquaculture (SSA) systems. Pilot testing of co-management was not carried out during phase 1 funding of MYFish. This reflected the challenges, complexity and the dynamic nature of the fishery management systems that need further characterisation research. This has particular relevance to better understanding the influence on inland fishery management of the decentralisation and reconcentration of fisheries laws and regulations to State and Regional Governments. In contrast, SSA pilot research, as a new activity could be undertaken in a relatively unimpeded setting within the DoF hatchery stations and also in villages involving farmers using participatory research techniques.

The methodologies applied to the SSA pilots used a combination of: (1) on-station research trials; and (2) participatory 'farmer-field school' approaches. These two methodologies have provided DoF with a systematic approach to design, test, monitor, and review the performances of the SSA pilots. It incorporates the controlled setting of the research station and the 'real-world' setting of producer households and farms with feedback from producers also contributing to the research process to help adapt and adopt new technologies and practices. The methodologies have become an important 'research in development' process for DoF and partner organisations and is based upon the CGIAR Research Program (CRP) Aquatic Agricultural System (AAS) participatory action research (PAR) approaches (2010-15).

Identifying new technologies and techniques

The pilots were developed using the findings of the characterisation studies and inputs from the symposia. These were presented with recommendations on how to develop the SSA pilots to the first reference committee meeting held in December 2013. The reference committee was set up at the beginning of the project and involved a tripartite grouping of ACIAR, WorldFish and the Department of Fisheries. The committee met annually and was formulated to provide guidance, assess progress and to re-orientate the project if necessary. Table 2 below provides a summary of the key challenges facing SSA development in the AD and CDZ that were presented and discussed with the reference committee.

Table 2: Challenges facing SSA development and the project beneficiaries

Challenges	CDZ	Delta
Technical.	• Some culture options with potential, (e.g. small pond culture of African catfish) are illegal.	▪ Controlled management of aquaculture systems in inter tidal zones and during wet season. ▪ Eel Culture popular but technology inadequate.
Climate related	• Droughts, Late rains, gaps in the rains; extreme heat. \ • Low water temps during cool season	▪ Flooding • Saline intrusion
Political	• Policies e.g. the digging of ponds in rice fields do not favour small-scale aquaculture;	
Institutional	• DoF and NGOs lack well trained field manpower;	
Cultural	• Cultural e.g. Some Buddhist communities will not kill fish.	▪ Fish from integrated livestock fish systems may be difficult to sell locally; ▪ Aquaculture perceived as a potential income source. ▪ There seems to be less interest in its use as a contribution to food security or dietary nutrition.
Resource Access	• Low availability of ponds and water bodies	▪ Poorer household access to pond/rice field resources ▪ Poorer household access to feed / fertilizers.

The recommendations for the SSA pilots were to promote:

- integrated agri–aquaculture systems such as fish in rice fields and fish and vegetables at household level;
- low cost small-indigenous fish species (SIS) that can improve pond productivity, incomes, and household food security and nutrition;
- short production cycle species (e.g. tilapia) suitable for seasonal rainfed areas;
- a diversity of aquaculture systems that suited different ecological, social and economic contexts; and
- SSA pilots that could serve as a basis for making amendments to land use policy challenges.

The recommendation on making amendments to land use policy reflects the challenges facing SSA growth and development. The current land use policy hinders the conversion of agricultural land that is used primarily for growing rice even when other productive uses such as fish ponds even if the environmental and economic conditions are favourable. Most rice farmers are aware of the restrictions and are not confident to convert paddy into other purposes. There is an inconsistency in applying the law and in some areas, the law is not enforced such as Thongwa Township in Yangon Region (see Figure 8 below) whilst in areas such as Mon State the rules are more strictly enforced.

On-station research trials

On station pilots were set-up at DoF hatcheries at Ta Lok Hla fishery station in Maubin and at Lay Dauk Kan in Yangon with the support of hatchery managers under the supervision of the Aquaculture AWG. The project introduced Mola carp and Climbing Perch (*Anabas testudineus*) to the station for breeding and nursing and also set up on-station trials of backyard Eel farming. The third SIS introduced was Snakeskin Gourami (*Trichopodus pectoralis*) for breeding and nursing in extensive ponds and was selected as it has a strong domestic market. The brood stock was transported to other DoF hatcheries for testing in the CDZ.

Participatory 'farmer-field school'

The process to set-up the SSA pilots through DoF involved development of hatchery techniques to produce the fry and fingerlings of SIS species. The first pilots tested two SSA systems in the AD: (a) rice-fish for small-scale rice producers as an alternative to rice-monoculture in well-irrigated areas with minor paddy field modifications and involved consultations with IRRI in the design; and (b) small indigenous species (SIS) and in particular Mola carp (*Amblypharyngodon mola*) added to small pond polyculture systems to improve homestead fish production, and food and nutrition security. The rice fish culture aimed to compare rice yield between rice paddies with fish versus rice paddies without fish so that the impact of adding fish to rice fields could be assessed. The SIS carp polyculture system aimed to improve income and production using different treatments. A M&E system assessed performance using indicators of production, gross income and consumption of fish measured through daily record books and monthly focus group meetings with producers. With backstopping from WorldFish, DoF designed a procedure to implement the pilot that was based upon the research process (see Figure 7).

Procedure for implementing SSA pilot farms

- Site selection
- Farmer selection
- Pond preparation
- Training of farmers
- Collection and raising of SIS brood fish
- Fish stocking
- Grow-out of fish culture
- M&E (weekly and monthly)
- Harvesting
- Documenting and report writing

Figure 7: Implementing procedures for DoF SSA pilots

The SSA systems were tested in two different agro-ecologies in fresh water and seasonally brackish water. The four townships selected were Kyautan, Pyapon, Daedaye that have seasonally brackish water and Maubin that is a freshwater area. The selection of Kyauntan Township provided an opportunity to test SSA in established pond systems created by rice farmers and used for fish production and irrigation. The image below shows old and new ponds next to paddy fields in Thongwa area (see Figure 8).

Figure 8: Image of Thongwa showing rice paddies and ponds

The SIS carp polyculture system pilot applied four different combinations of tilapia (*Oreochromis* spp.), silver barb (*Barbonymus gonionotus*), silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*), mola (*Amblypharyngodon mola*) and climbing perch (*Anabas testudineus*) in ponds with an average size of 0.04 hectares. The stocking treatments were: (1) Carp spp. (control) in 34 households; (2) Mola and other carp spp. in 245 households; (3) climbing perch and other carp spp. in 10 households; and (4) Mola, climbing perch and other carp spp. in 10 households. The rice-fish culture was applied to modified rice fields with a refuge pond (3 x 3 x 0.5 m) in the lowest part of the rice field and an elevated dyke about 50cm in height in the perimeter. Rice-fish fields were approximately 0.4 Ha and stocked with tilapia, silver barb and mola in 10 households.

The selection of producers was made by the DoF and the Ministry and over 300 households were stocked with SIS species together with traditional carp polyculture to provide for a nine-month grow-out period. The system of data collection involved a farm-record book and training of pilot farmers in water management, feeding and data collection. The data collection included the monitoring of a sub-group of 30 HH that met monthly in focus group discussions of both men and women. The selection criteria for SSA beneficiaries required from each household included:

- presence of a small fish pond;
- limited opportunities for other livelihoods;
- an interest in fish farming;
- lived permanently in a village;
- a willingness to share their experiences with others; and
- agreed to guidelines developed by MYFish that did not allow the producer to stock fish other than those identified for the pilot farm.

The SSA pilot results were reviewed by DoF and WorldFish and lessons learned documented and presented in seminars and also at the third national symposia held in NayPyiTaw in December 2014. Adaptions to pilots through this process included increasing the size of initial fingerlings to reduced mortality in transport and shorten the grow-out cycle and to control and prepare for flooding with the inclusion of climate proofing technologies such as cage-netting within the pond to secure fish during floods.

5.1.4 Objective 3: To strengthen the capacity of Government, private sector and non-government organisations to carry out appropriate research & development for the fisheries sector

Capacity building inputs focussed on three areas: (1) strengthening the technical skills and capacities of DoF and partner organisations in small-scale fisheries and aquaculture R&D and extension; (2) building DoF's institutional capacity to manage and administer R&D projects; and (3) developing research networks and collaborations to undertake R&D and share information across the sector

Strengthening technical skills and capacities

There are no fishery universities or a faculty where courses on fisheries and aquaculture R,D & extension are taught. The building of the technical skills and capacities of DoF and partners were facilitated through a series of short-course trainings, workshops and on-the-job trainings with WorldFish scientist providing continuous backstopping support to DoF in R&D and extension. Short courses included nutrition and communications, participatory rural appraisal and English language for researchers. A full list of the trainings provided is summarised below in section 6. Achievements against activities tables under Activity 3.5. Capacity building. Capacity building also involved exposure visits to Bangladesh, Thailand, Philippines and Cambodia and provided training in fish identification, research methods, fishery management and small-scale aquaculture.

Building DoF's institutional capacity to manage projects

Strengthening DoF's institutional capacities were addressed through the establishment of the AWGs on aquaculture and capture fisheries. Technical staff that had the potential to lead the AWGs were ask to provide a CV and promising candidates interviewed by WorldFish and recommendations made to the DG.

Institutional capacity was also strengthened through the provision of a budget and administration training. The ACIAR project was the first intervention to allocate funds directly to DoF and this created a number of logistical challenges for the department. These were mitigated by the integration of MYFish within the institutional structure of DoF and having a physical presence of WorldFish technical and administrative staff in the office.

The administrative collaboration between WorldFish and DoF was initiated through discussions on the project agreement document called a RoD (Result of Discussion). Similar to a MoA, the RoD helped define the institutional processes and mechanisms that WorldFish and DoF agreed to abide by in order for the partnership to function. The RoD promoted transparency and provided a unique opportunity for DoF to garner feedback on the project at Regional/State Government levels in the Sagaing, Megway and Mandalay that make up the CDZ and the in Ayeyarwady Region where approvals were required. The project proposal was translated into Burmese and provided details of the partnership arrangement with DoF and with NGOs via the Food Security Working Group (FSWG), Universities and private sector facilitated through the Fishery Research and Development Network (FRDN). Importantly the RoD provided a detailed budget and allocations between the partners. No other project previously has been as transparent particularly with budget data.

Fund allocations to DoF were supported with administrative training for both DoF and WorldFish national staff. These trainings were facilitated in Phnom Penh at the regional WorldFish office in September 2013 and repeated each year. In addition, administration staff from the Cambodia regional office undertook trainings in Yangon with visits by the regional business manager and accountant. DoF attached an administrative officer to the project and together with the WorldFish accountant and backstopping from Cambodia, DoF were able to allocate funds and provide financial reports to ACIAR and CGIAR standards. The WorldFish accountant and administrative officer also supported DoF in preparing and liquidating budgets for research activities undertaken by the AWGs.

Developing research networks and collaborations

Under the FRDN initiative, the piloting of a funding mechanism for mini-research grant projects on fisheries aimed to engage researchers and development practitioners across the sector. There was no history of collaboration between the government, NGOs, universities and the private sector in fisheries up until this juncture and the concept and design of the FRDN had to engage representatives from across the sector in agreeing to collaborate and also to participate in developing the mechanisms to submit and manage grant proposals.

The FRDN small-grants program needed time to develop and build the trust and confidence in the partners particularly between civil society and DoF. The development of the FRDN was built upon a series of partnership meetings that started in November 2011 and carried on throughout 2012. The meetings were facilitated through the NGO association the Food Security Working Group (FSWG). The FSWG was a relatively new association and represented by NGOs, CBOs and INGOs. It had dynamic leadership and a mandate to raise awareness and engage civil society in learning and capacity development in rural development technical and policy. The meetings brought together senior staff at deputy DG level from DoF, professor level from Yangon University, CEO level from the national shrimp association from the Myanmar Fishery Federation (MFF), and the CEO of the FSWG chaired the meetings with WorldFish providing technical support to the secretariat. The key result of these meetings was an agreed methodology and research protocol for launching calls for research proposals (See Appendix 2).

Two calls were made for mini-research projects, one for the AD and the other for the CDZ. A total of 33 applications were submitted and 20 mini-research projects approved (10 each in the CDZ and AD). In the second year of the initiative and additional two projects were funded by the FRDN with co-funding from the Global Environmental Facility (GEF) funded Bay of Bengal Large Marine Ecosystem (BOBLME) program. The range of studies included: four on fish markets and value chains; four on capture fishery resource assessments; four on livelihoods; one on food, security and nutrition; and seven on aquaculture. The national FRDN committee reviewed and approved $62,000 for CDZ and $62,000 for mini-research projects in the AD.

6 Achievements against activities and outputs/milestones

Objective 1: To characterise the fisheries sector in the Ayeyarwady Delta (AD) and to assess the scope for fisheries development in the Central Dry Zone(CDZ)

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	Compiling existing information and databases	National fishery data-bank	January2013 to Dec 2016	• Data set with repository of documents and reports compiled and stored digitally on MYFish server (2012-16); • AWG surveys and SSA pilot locations shared with the Myanmar Information Management Unit managed by UNOCHA (MIMU) P-codes making it publically available (2012); • Creation of a FishBase node in Myanmar, in collaboration with universities, to link Myanmar fish researchers to the global fish research community and integrate knowledge to FishBase database (2014); • Migration patterns and spawning sites for 31 species of commercial or conservation interest, including Hilsa (*tenualosa ilisha*) mapped across AD and the CDZ (2015); • Refurbishment and contracting completed for DoF to develop an institutional fisheries repository – the Fisheries Information Center (2015); • DoF establishes the AWG for the FIC with one lead librarian and six support staff; (2015) • Launch of the Fishery Information Center website (Jun 2016)
1.2	Complete a multi-disciplinary scoping exercise for AD	Scoping report	February 2013	• Scoping survey December 2012; report identifying priority research areas and knowledge gaps distributed to DoF and sector partners (2013); • Scoping report highlighted short, medium and long-term researchable projects and identified the following bottlenecks and inefficiencies in the fisheries system in the AD: - Policy and governance: land use policy not favourable for expansion of aquaculture (e.g. conversion of rice field land to ponds); - Capture fisheries: continued fish stocking in the floodplain with aquaculture species and limited knowledge of (i) the efficiency of the re-stocking efforts, or (ii) their impact on the natural biodiversity; - Aquaculture: institutional support (training) and services (fish seed networks, low cost feeding systems, financial services) not well developed and not reached scale where SSA can grow, sustain and create impact at scale; - Livelihoods, gender and markets: Livelihood surveys indicate chronic food insecurity with 52% of households surveyed unable to meet daily food needs with13 % relying solely on food from their fish catch;

1.3	National symposium on '*Fisheries of the Ayeyarwady Delta*'	Symposium Proceedings	April 2013 to Jan 2015	• Completed in March 2013; • Symposium held in Yangon (MFF) and attended by 74 participants from DoF, NGOs, Universities and international organisations; • Presentations (22) made by Universities and DoF mainly on aquaculture and capture fisheries; with other research themes provided by NGOs; • Symposium proceedings translated and published in June 2014 and distributed to partners; • A third 3-day symposium and Impact Pathway Workshop at national level was held in Nay Pyi Taw in December 2014 attended by 132 participants; • First 2-days, researchers presented their research work funded through the AWGs and FRDN. On the third day, an "Impact Pathway Workshop" was convened to prioritize research findings and to identify interventions which could further supported by MYFish; • National 2014 Symposium Proceedings produced (Jan 2015).
1.4	Designing and implementing studies for the characterisation of AD	A detailed research plan for 2013 / 14	May 2013 to Jan 2016	• Annual planning with DoF continues with the following studies and surveys contributing to the characterisation of the AD: • Small-scale household aquaculture survey: analysis of socio-economic characteristics of 139 SSA households, their livelihood strategies and contribution of aquaculture. • Commercial (SME) aquaculture survey: analysis of commercial fish farming in AD, opportunities for mutually beneficial linkages between large and small scale operators. • Leasehold characterisation survey: study of 180 leasable fishery areas in 12 townships conducted, on water body characteristics, management, productivity and marketing of catches. Data analysis conducted. • Fish for food and nutrition security: secondary and primary household consumption data review to ascertain the role of fish and OAA for food and nutrition security in Myanmar • Value chain assessment: characteristics of Hilsa shad value chain, and who benefits in AD. • Livelihood assessments: characteristics of Hilsa fisher families in AD. • Distribution, migrations and breeding of Hilsa (*Tenualosa ilisha*) in the Ayeyarwady system in Myanmar Collaborative study with FAO/BOBLME.
1.5	Summarising findings from the AD study into a series of technical publications, policy recommendations, and datasets	Professionally produced document describing the fisheries resources of AD	June 2014	• Poster on actual fish size at maturity of 14 commercial species produced by DoF in collaboration with Yangon and Mandalay Universities; 1,000 copies of the poster produced and distributed to DoF officers; • Updated information synthesized into a booklet that highlights main trends and issues for better management of fisheries. Booklet provides and updates statistics, trends, issues and opportunities between

				2003 and 2013; (Soe, K. M., et al., Myanmar Inland Fisheries (Ayeyarwady Delta and Central Dry Zone, 2003 -2013); • Poster presentation to the global conference on inland fisheries at FAO under governance theme highlighting learning though R&D and links to decision-making: Soe, K. M., Win, N., Johnstone, G. M. and Tezzo, X. How Can Science Strengthen Adaptive Management Capabilities in Myanmar Inland Fisheries; Global Conference on Inland Fisheries, FAO Headquarters, Rome, Italy (26 – 28 January 2015).
1.6	Complete a multi-disciplinary scoping exercise for CDZ, involving DoF and other stakeholders using CRP AAS participatory diagnostic methods	Scoping report with priority interventions identified for discussion and confirmation at the symposium	July 2013	• Scoping mission completed in July 2013; report highlighted short, medium and long-term researchable projects and concur some of the policy findings of the AD scoping with additional insights including: - CDZ is characterized by a wide diversity of agro-ecological systems ranging from the upland areas with limited/irregular access to water to the better irrigated lowlands where most of the aquaculture production takes place; - Aquaculture production is centralized in the North of the CDZ (around Mandalay and Shwebo). Fish are harvested year-round following a short grow-out period and observations suggest potential for an increase in systems productivity with minimal technical interventions; - Capture fisheries appear to play an important role in livelihoods of the CDZ: and practiced on irrigated/seasonally inundated floodplains which are managed under lease arrangements. Wild fish also captured to a lesser extent from main river bodies (open fisheries) and observations indicate a probability for significant 'hidden' fish resources in the CDZ; - Livelihoods, gender and markets: the role of fish in rural livelihoods and welfare is undervalued; fish are abundant on markets and appear to play an important role in livelihoods; rainfed farming systems are vulnerable to climatic perturbation and fisheries may not be managed in proportion to their contribution to local livelihoods.
1.7	Preparing a symposium on the '*Potential for fisheries in the Central Dry Zone'* to identify key themes, areas and develop frameworks for the assessment study	Symposium Proceedings with agreed framework for the CDZ fisheries potential study	December 2013 to Dec 2016	• Symposium held on December 3-4 2013 in Mandalay; • 61 participants from DoF, NGOs, Universities from all three regions of CDZ and across sector and international organisations • 20 presentations made; with mainly descriptive research on fishery presented by Universities and DoF and NGOs project overviews; • Symposium proceedings translated and completed January 2014; • Annual symposium and final workshop held in Dec 2016.

1.8	Designing and implementing studies that describe the natural resources with fisheries potential as well as the social, cultural and economic characteristics of CDZ	Research activity planning for period 2013 to 2016	January 2013 to Jan 2016	• Annual planning with DoF continues with the following surveys contributing to better understand the natural resources with fisheries potential in CDZ: • Small-scale household aquaculture survey: secondary data information; key informant interviews; focus group discussions and household survey of over 200 households in CDZ (Sagaing, Mandalay and Magway) characterizing SSA, opportunities and challenges. • Migration study of Hilsa (*tenualosa ilisha*) and 30 commercial fish species included CDZ. Collaborative study with FAO/BOBLME. • Assessing the potential for developing a cage culture: study focus on cage culture potential in reservoirs in Magway Region CDZ. • Comparative study on aquaculture feeds: testing effect of different feeds on the growth rate of poly-culture carp systems in the CDZ.
1.9	Summarising findings from the CDZ study into a series of technical publications, policy recommendations, and datasets	Professionally produced document describing the fisheries potential in the Central Dry Zone	June 2015	• Booklet produced on both the (Ayeyarwady Delta and Central Dry Zone, 2003 -2013) and provides an update on statistics, trends, issues and opportunities between 2003 and 2013; Soe, K. M., et al., 2015. Myanmar Inland Fisheries (Ayeyarwady Delta and Central Dry Zone, 2003 -2013).

PC = partner country, A = Australia

Objective 2: To identify, test and then demonstrate new approaches to increase productivity, efficiency, sustainability and equity in fisheries production systems in the Ayeyarwady Delta and the Central Dry Zone.

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Based on the AD fisheries characterisation study and the CDZ potentials study, identifying priorities for pilot interventions and research	Reference Committee Minutes on recommended studies and sites for pilot intervention development	Dec 2013 to May 2015	• Reference committee meeting held in December 2013 and agreed process for designing pilots and priority locations in the AD; • Geographical areas identified following the SSA survey in the three salinity gradients of the delta, and three water availability gradients in the CDZ; • Reference committee meeting held in May 2015 and agreed process of designing SSA and co-management pilots and priority locations in the CDZ;
2.2	Designing a set of specific pilot and research studies for DoF R&D and township implementation, and selecting themes for R&D projects through the FRDN mini-research fund	Work plans agreed by DoF & FRDN on location and process of implementing pilot demonstration research projects	May 2014 to June 2016	• Pilot research projects selected in AD and CDZ to undertake testing and collaborative research include: • SSA pilots (Delta): (a) testing different rice-fish approaches for small-scale rice field owners in 10 households; and (b) test small indigenous species (SIS) particularly Mola added to small pond polyculture to improve homestead food and nutrition security and increase production in over 300 households; farmer field trails including design of a farm-record book and training of pilot farmers (water management, feeding, data collection); • DoF Hatcheries - introduction of SIS in DOF hatchery Ta Lok Hla DOF Fishery Station,

				Maubin Tsp; Research pilots implemented at Lay Dauk Kan DOF Station and involving hatchery managers, DOF staff; testing included backyard eel farming fed; snakeskin gourami farming, breeding and nursing activities and extensive pond farming trial; • SSA pilots (CDZ) - current pilots implemented by DOF grantees under the FRDN in the three regions: DOF Mandalay: Backyard culture of stinging catfish, walking catfish and swamp eel; DOF Sagaing: Testing different feeding regime in pond carp polyculture system; and DOF Magway: Cage culture of tilapia in reservoirs. • SSA pilot design for AWGs in the CDZ includes; (a) Homestead subsistence pond aquaculture; carp plus Tilapia-Mola (b) cage and pen culture with short culture cycle species (Tilapia-Mola); and (c) micro-scale tank aquaculture (WISH Ponds) with catfish-tilapia
2.3	Establishing basic research study protocols, Standard Operating Procedures (SOP) and reporting formats for organisations collaborating with the project	Research protocols and SOPs produced and agreed by DoF and FRDN	April 2014	• Modality for undertaking the pilots completed in Q3 2014 and uses on-station and on farm systems to test aquaculture; data and extension involves community-based facilitators, DOF township officers and DoF hatchery staff; • Research protocols (methods and data collection systems) designed by WorldFish technical experts together with DoF staff; • M&E system design includes: monitoring project progress in delivering on activities and outputs; monitoring technical inputs for the pilots; and monitoring outputs of the FRDN.
2.4	Implementing pilot and demonstration interventions and comparative trials to examine the suitability of novel production and management systems	Reports, studies and briefs on a series of pilot demonstration projects	December 2014 to Dec 2016	• Pilot projects have focussed principally on small-scale aquaculture and have been set up in the AD and CDZ, • Results are being documented and communicated to investors and development agencies; • LIFT fund has approved funding ($3.3M) for scaling small-scale aquaculture scale aquaculture technologies developed under MYFish.
2.5	Supporting the DoF in producing a periodic newsletter and hosting 'Fisheries Research & Development Annual Meetings'	The first DoF fishery newsletter produced after the first 'Fisheries Research & Development Annual Meetings'	Oct 2014 to June 2015	• A third edition of MYFish newsletter produced in October 2014 detailing the research activities. • Newsletter includes a message from the DG of DoF and 1,000 copies are produced and distributed to all DoF offices in the Delta and CDZ. The newsletter is produced twice a year in English and Burmese.

PC = partner country, A = Australia

Objective 3: To strengthen the capacity of Government, private sector and non-government organisations to carry out appropriate research & development for the fisheries sector.

No.	Activity	Outputs/ milestones	Completion date	Comments
3.1	Establishing the Fishery Research & Development Partnership	Protocol on establishing the FRDN agreed by all members	March 2013 to Dec 2016	• Total of 7 FRDN Steering Committee Meetings convened from 2012 to 2016; • Setup of 1 National and 2 Regional (AD/CDZ) FRDN Committees together with the development of standardized application and selection procedures involving reciprocal ranking evaluation methods. • Pre-screening of draft proposals now done by each member institution and grant agreements made with individual researchers
3.2	Establishing activity groups within the DoF on Capture fisheries and Aquaculture that will receive training and capacity building	Activity groups established within DoF and representing capture fishery and aquaculture interests in DoF	December 2012 to Dec 2016	• Commitment of 6 part-time and 5 full-time staff from DoF assigned as follows: Project Administration: 2 staff (1M/1F - part-time); AWG-Aquaculture: 3 staff (3F - full-time); AWG-Capture: 2 staff (1M/1F - full-time); and Library (FIC): 4 staff (4F - part-time) • Setup of routinized modalities for DoF between AWG and project administration teams to support the allocation and administration of project funds.
3.3	Setting up a managed research funding system for the FRDN that includes a MoU for managing mini-research-projects and train the designated administrator in ACIAR accounting requirements and procedures.	Minutes of the FRDN Funding Board meeting indicating that mini-research funds are well managed and successfully administered by the FSWG	May 2013 to Dec 2015	• Minutes of the FRDN meetings outlining the agreement to manage mini-research projects; • FRDN committee agreed to manage the funds collectively and implement research activities in support of the characterisation study in AD as initial activity of fund; • Two mini-research grant calls made in the AD and CDZ and 33 applications were submitted and 22 mini-research projects approved (10 each in the CDZ and AD plus two funded by BOBLME); • Range of studies include four on markets and value chains; four on capture fishery resource assessment; four on livelihoods; one on food, security and nutrition; and seven on aquaculture; • Fourteen reports completed; FRDN committee approved $62,000 for CDZ and $62,000 for mini-research projects in the AD.
3.5	Training key individuals in DoF and FRDN in field research topic identification, design, implementation, protocols, data analysis and management, and reporting.	Report on R&D training for FRDN/ DoF	March 2013 To June 2016	<u>Exposure visits and regional training</u> • 12 persons (10 female and 2 male from DOF and Myanmar Universities) trained 5 days on Fishbase Basic encoding, by Fishbase trainers from the Philippines, in Yangon, September 2013. • 6 persons (4 female and 2 male from DOF and Myanmar Universities) trained 5 days on FishBase Refresher and Advance Encoding, by FishBase trainers, in the Philippines, October 2014. • 3 staff (2 female and 1 male) from Dagon University trained 3 days in environmental economics, by EEPSEA/WorldFish, Thailand, in May 2014;3 DOF staff (1 female and 2 male) attended a 5-day WorldFish workshop training on SIS in aquaculture, Bangladesh, March 2014. • 2 key project personnel (2 male) visited

				Cambodia 7 days to discuss community fisheries in Oct 2013 and Bangladesh for 4 days to explore SSA options in May 2014. • 3 DOF staff (1 male and 2 female) trained 5 days in project administration and budgeting, Cambodia, July 2013. • 1 DOF Technical staff (male) trained 5 days in workshop convened by WorldFish on swamp eel breeding, Indonesia, September 2014. <u>R&D methods training and skills development</u> • 6 DOF and WorldFish staff of the SSA survey team (4 female and 2 male) trained 3 days on Gender, by WorldFish, in Yangon, Jan 2014. • 29 DOF and township officers (26 male and 3 female) trained 3 days in the collection of data for leasehold survey, by WorldFish, in Yangon and Delta Townships, March 2014 • 43 DOF staff from Delta and Central Dry Zone (female 18 and male 25) trained 5 days in structured survey questionnaire for implementation of Small Scale Aquaculture Survey, by WorldFish and DoF in Mandalay, Sagaing and Magway, in November 2014 • 2 DOF staff (2 female) trained 2 days Nutrition sensitive interventions, by LEARN/Save in Yangon, April 2015 • 12 DOF staff (3 male, 9 female) trained 36 hours over 6 months in tailored English (corporate Training covering research writing, verbal communication), by SPEAK, in Yangon starting May 2015. • Partnership with FAO agriculture and fisheries sciences digital repository (www.fao.org/agora/en/) to provide Yangon University Library (YUL) and Universities Central Library (UCL) with access to their database (June 2016) • Training provided to 65 university researchers from AD and CDZ in use of the library technology (2016) <u>Farmer field school capacity building in SSA</u> • 329 fisher households involved in pilot trials (237 men / 92 women) 2014 to 2016

PC = partner country, A = Australia

7 Key results and discussion

7.1 Embedding the project within the institution of DoF

Key Result

- Embedding the project within the Department of Fisheries (DoF) helped to build trust and understanding between DoF and WorldFish, it enabled DoF staff to successfully carry-out fishery research and development from within DoF, and resulted in a number of international investments in fisheries adopting the same approach

Discussion

The design of MYFish aimed to forge close working ties between WorldFish and DoF. This was achieved by embedding the project office and WorldFish technical and administrative staff within DoF in Yangon. In addition, the project employed the ex-director of the R&D Division, U Khin Maung Soe (KMS) who became a critical liaison and bridge-builder between WorldFish and DoF. Trusted and respected by government, KMS assisted in project design and negotiations, and the DG agreed to locate the project office within the Research and Development (R&D) Division of DoF in Yangon. This was the first time that an international research institution was located within DoF. At the time of project design, the DG and senior DoF staff were located in Yangon providing an ideal opportunity for interaction. However, in 2012 the DG office and senior staff were moved to NayPyiTaw in accordance with decentralisation policies. Despite the change, the project office remained within DoF's Yangon Regional Fishery Office that provided daily interactions between DoF and WorldFish.

The embedding of the project in DoF proved to be critical to the success of MYFish and helped to develop R&D activities from within the institutional framework of DoF. The arrangement to engage the 6 part-time and 5 full-time DoF staff to the project was through attachment and not secondment, which maintained their status as DoF staff. In contrast to other fishery projects that seconded government staff taking them out of government to work full time on a project, the MYFish approach kept DoF project staff within DoF, which helped human resource development.

The embedding of the project also helped to better align the outputs of MYFish with those of the government and DoF and proved particularly important in the changing and dynamic politic of Myanmar. Having the project office and international staff based within DoF with an open-door policy also enabled senior and none project staff to drop-by and see what the project was doing. The Yangon DoF office continued to function as the main meeting place for the Minister, deputy Minister, DG and senior staff, and consequently the project received visitors every day. The set-up helped to build trust and mutual understanding between DoF and WorldFish and better facilitated capacity building and institutional strengthening.

Of the note, the embedding approach taken by MYFish has led to the development of a country office for WorldFish and has been repeated by other fishery development projects. Notably the GiZ Fish Trade Program, the EU investment in aquaculture (MYSAP), and DANIDA's investment in coastal co-management. Each project has negotiated and designed their project offices to be located physically within the DoF in Yangon and this has created an international fishery project hub within DoF.

7.2 Strengthening institutional capacity to administer and carry-out research projects

Key Result

- MYFish was the first fishery project to allocate funds directly to DoF to support logistics and research operations. As a result, the institutional capacity of DoF to oversee and successfully administer research and development project funds has strengthened and has been recognised and adopted by other donors and investors

Discussion

MYFish allocated a sizeable operation budget of approximately AUD$0.5M to DoF. This placed the onus and responsibility to manage and administer project funds with DoF in partnership with WorldFish. To strengthen DoF's institutional capacity to do this, WorldFish provided regular administration training and budget oversight throughout the project lifecycle. DoF attached an administrative officer to the project office and together with the WorldFish accountant and administrative officer they supported DoF in preparing and liquidating budgets for research activities undertaken by the AWGs. With technical backstopping from WorldFish's regional business manager based in Cambodia, DoF were able to provide 6-monthly financial reports to ACIAR and CGIAR standards.

The result of placing a significant proportion of the operation budget with DoF has proved to be an important output for DoF that now have the skills and administrative tools to manage R&D projects. The success of the approach taken by MYFish was recognised by the Livelihood and Food Security Trust (LIFT) that sort to fund fisheries development despite limitations on been able to fund government directly. The audited reports of the MYFish project accounts produced by DoF helped persuade LIFT to amend its regulations to allow small-grant funding of government departments and as agreed under the LIFT funded MYCulture project. Grants up to Usd$10,000 could be allocated to DoF and Universities to carry-out activities within the project. Similarly, the EU project MYSAP accepted a similar arrangement and allowed the funding of DoF to support SSA development as designed by MYFish. The arrangement is continuing under the second phase of MYFish (2017-2020).

7.3 Developing modalities to implement research and development

Key Result

- The project developed two research modalities to undertake R&D that combined capacity building with knowledge generation and learning. The Activity Working Groups (AWGs) and the Fishery Research and Development Network (FRDN) have remained the principal mechanism to do research within DoF and across the sector and both modalities have been incorporated into other development projects in fisheries and have received funding by donors.

Discussion

When international research institutions carryout research in a developing country, the research is normally designed, planned and managed by international specialists. Engagement of national staff in the research process particularly from government, NGOs and private sector tends to be as low skilled enumerators or data collectors at village levels. The problem with this approach is policy makers and senior government staff can often become removed from the research process and importantly the results. The inclusion and design of the AWG and FRDN in MYFish aimed to address this issue and rebalance the research responsibility and ownership of the results so it belongs to government and national research institutions including NGOs and private sector organisations.

The AWGs proved to be a successful mechanism to achieve this and in organising DoF staff to carry-out research and in bringing the research process closer to the policy and decision

makers in DoF. Responsibility for organizing the AWGs remained with DoF that were led by senior staff with technical experience in aquaculture and capture fisheries. The AWG formulation was agreed in the project document and detailed in the Result of Discussion (RoD). This engaged the Director General of DoF in approving the selection of staff.

The AWG function and formulation was initially a challenge for DoF that were used to international projects seconding and overseeing staff to carryout project tasks. However, by placing a significant proportion of the research operating funds with the DoF the responsibility for planning and implementation shifted to DoF and the AWGs. Working with WorldFish staff, the AWG leaders had to develop proposals to plan research activities and select staff to participate. This was a particularly useful method to engage DoF staff at district and township levels. The AWGs also proved effective in building the capacity of staff to do research within DoF with senior DoF staff training junior staff, and this resulted in greater ownership and understanding of the research outputs. This has helped to change the attitude and relationship of DoF to fishery science and also helped DoF take a leading role in R&D.

The second research modality, the Fisheries Research and Development and Network (FRDN), was an informal research network that brought together the DoF with Universities, private sector and NGOs to share knowledge and to identify research priorities. The challenge of the FRDN was maintaining regular coordination and communication with different partners that were engaged in one or more of the 20 mini-research grants. The contracting process where specific outputs were linked to payments did help improve coordination. The contribution to the overall characterisation studies were mixed due to quality variations. This is reflected in the publication outputs where some FRDN studies have been published through the DoF whilst others remain as project technical reports. However, the FRDN was new to the sector and R&D capacities been strengthened through assistance in methodology formulation, research implementation and quality control. Importantly the FRDN has created a platform for policy debate where research findings are discussed amongst peers and with government. It has also created important relations and links with international research institutions that re increasingly supporting research and bringing in expertise from outside of the country.

The AWGs and FRDN have been accepted and adopted by other donors and fishery development projects. The two mechanisms are incorporated into the LIFT funded MYCulture project and EU MYSAP projects. The DoF has also endorsed the two modalities within project agreements developed with DoF describing the engagement of DoF staff through the AWGs and Universities, NGOs and private sector (MFF) through the FRDN.

7.4 Building DoF and sector capacity in research and development

Key Result

- MYFish applied different capacity building, training and learning techniques and activities to support DoF staff and FRDN research partners undertake research, development and extension activities. As a result, there is better awareness within DoF and sector of the skills needed to carry out research, there is improved capacity within DoF to lead and facilitate research training and capacity building techniques have been extended to other development projects that are funded by other donors.

Discussion

At the beginning of MYFish, DoF had no fisheries or aquaculture curriculum developed, had no short-term courses or provided any formal technical training to staff in SSA. There were no SSA extension services and no coordination of R&D in the fisheries sector or any inter-sector R&D collaborations. There was no post graduate training or university grants for research, and the Universities that were working in the sector were mainly working in isolation with data on the sector scattered with no centralization of information.

MYFish provided training to DoF, Universities and NGOs as well as directly to beneficiaries and farmers including pedagogical courses on the training of trainers (ToT). Throughout the life of the project over 20 short-courses were convened involving almost 200 DoF, NGO, University staff (86 female & 91 male). The training included courses in baseline, M&E, surveys in knowledge, attitude and practice (KAP), fish identification facilitated by FishBase and in the design and use of farmer record books. Capacity building activities were provided by DoF to producers including training in SSA pilots to over 300 producer households (237 men / 92 women) in one or more production system.

MYFish has held four fisheries symposia to present research to peers and the project has been instrumental in establishing a scientific publication system for DoF that is referenced with a unique publication number authorized by the Ministry of Communications and Information. This means that documents published by DoF are cataloged and referenced under the university central library system and are accessible beyond the life of the project.

MYFish R&D training courses and technologies have now been scaled out to other development projects notably LIFT's MYCulture and the EU MYSAP projects. MYFish SSA training has been standardized into eight modules for extension agent training under MYCulture. Courses included: social ecology research within aquaculture projects; basic aquaculture; small scale aquaculture and dyke cropping, gender survey training, livelihood baseline survey training; fish seed production in DoF Station and training on SIS breeding and nursery technology. MYCulture has been able to scale out these trainings in SSA technologies to 71 people from DoF, NGOs, and Universities (46F / 25M) in 2016. The MYFish FRDN small grants program and training has also been extended to MYCulture and MYSAP projects with USD $150,000 allocated to FRDN small grants.

7.5 Characterising inland freshwater capture fisheries

Key Result

- The characterisation studies have produced extensive documentation by DoF, WorldFish and FRDN partners of sector practices in inland capture fisheries.
- The results of the characterisation of capture fisheries are providing important baseline data that is been applied to improve fishery management.
- Highlighted in this section are key findings from the inland fisheries leasehold survey.

Discussion

The rationale for the leasehold survey was to gain a better understanding of inland fisheries management practices, resource status and trends as a basis for improving fisheries management practices. The research design was led by WorldFish and the research planning and implementation by DoF's AWG on capture fisheries.

The leasehold characterisation study surveyed 180 leasable fishery areas in 17 townships in the Ayeyarwady Delta in 2014. The study surveyed water body characteristics, management, productivity and marketing of catches. Data analysis highlights that lease holders do not have full control over the leased environment. Over 80% of the surveyed leasable fishery areas are partially used for crop cultivation in dry season and/or are affected by water management for agriculture purposes. A great majority of the cultivated leased area is used by those other than the fishing lease holders. Significant numbers of the lease holders are inexperienced in managing the lease and need technical support. 86% of the leases are held by individuals rather than groups, and 27% of the leaseholders have less than 1 year of experience managing the same lease. Less than 10% of the lease holders receive any assistance from DoF, MFF, or NGO. 79% of the leases are stocked with fingerings from hatcheries, and 49% conduct feeding in their leased areas, but the overall effectiveness of these practices is unclear. Over 70% of the surveyed leases experience incidence of illegal fishing and poaching with varying degree of severity.

Total lease prices reported ranged from 50,000 Kyats to 165 million Kyats. Per acre, average lease prices varied from 366 Kyats for leases in main rivers to 14.7 million Kyats for leases in

Bogale Township. The unit price of leases tended to be higher for those with higher productivity and higher value species. Between 2007 and 2012, most leases experienced declining annual fees. Whereas for the period 2012-2013, 72% experienced an increase in lease price compared to the previous year.

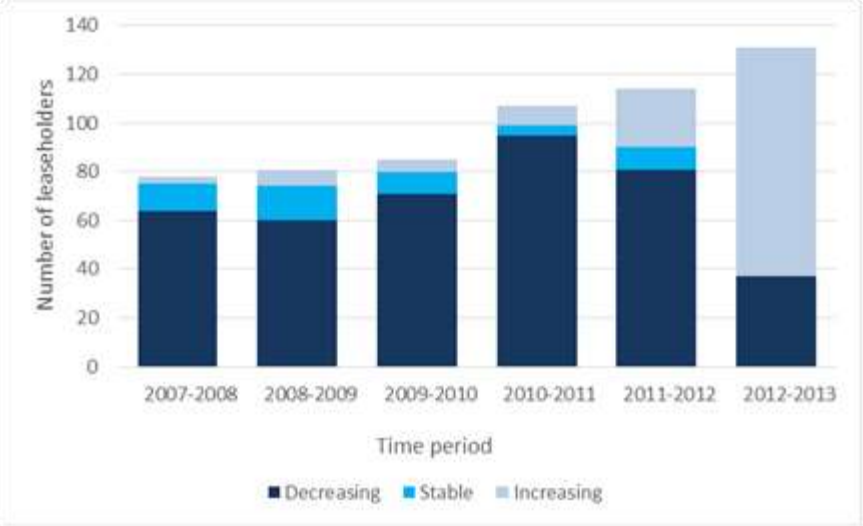

Figure 10. Trend in lease price

Men and women in leaseholder households allocated different amounts of time to livelihood activities (Figure 11). Generally, women spent more time on domestic activities and running businesses, whilst men spent more time on farming, fish processing, and off-farm jobs. Although average time on fishing and lease operations was higher for men (52%), women also devoted significant amount of time (40%) to these activities.

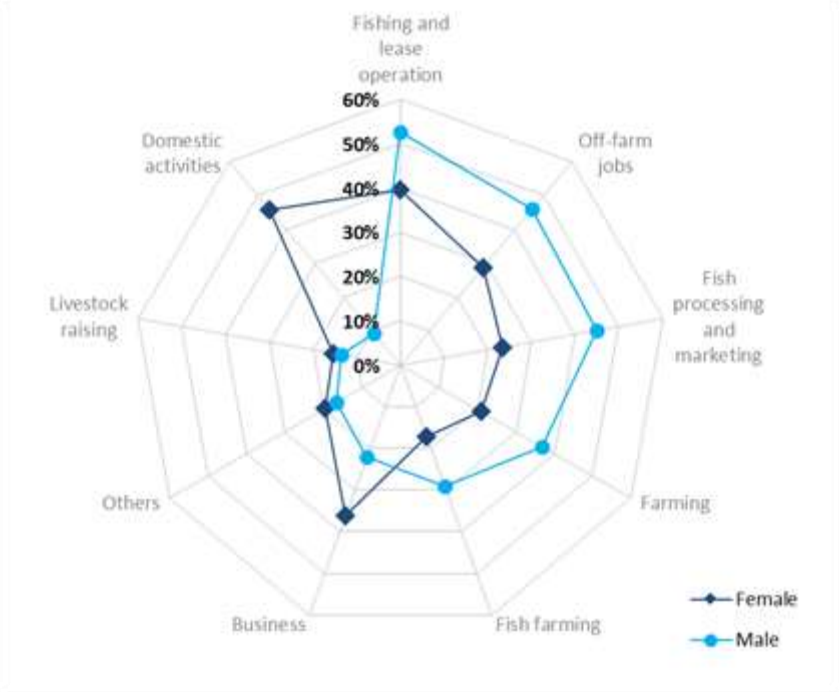

Figure 11. Average proportion of time spent by men and women on income activities

Leaseholders were asked to list the 10 most common species in their leased waterbody. Nearly 70 species of fish (including crustaceans and eels) were reported. This highlights that the leasable fisheries in the Ayeyarwady Delta harbour on a diverse range of species.

A majority of catch species are indigenous to the Ayeyarwady Delta; however, a number of non-native species, such as snakeskin gourami and tilapia, were also found in landings.

Figure 12 below shows the number of leaseholders who caught the 24 most commonly reported species.

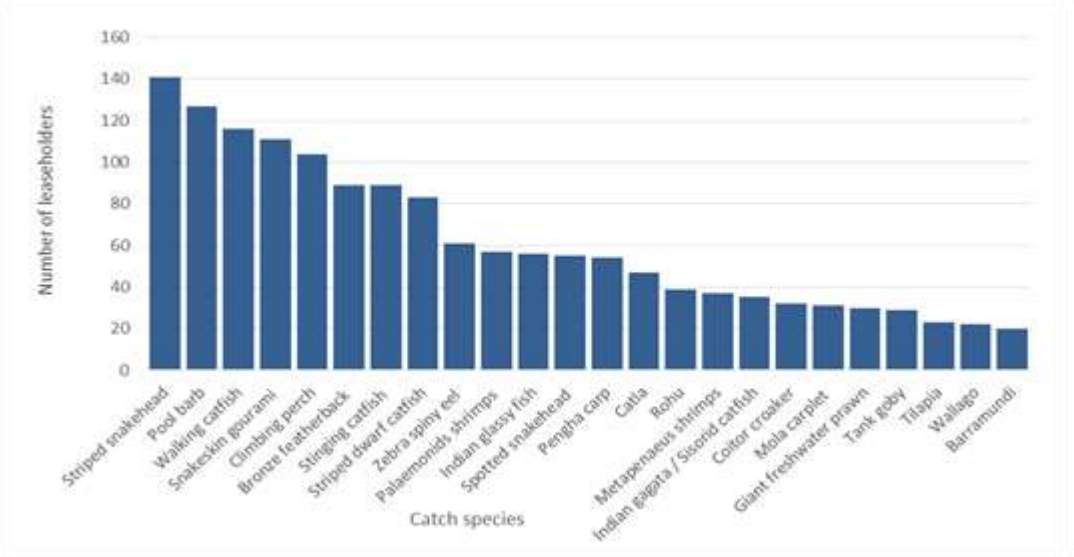

Figure 12. Top 24 most commonly caught catch species as reported by leaseholders

Recommendation for improving leasehold management

Addressing the challenges faced by leaseholders will require technical and legislative support from DoF and other associated organizations. Proposed actions and relevant actors to be involved are summarized below.

- Develop comprehensive electronic inventory of leasable fisheries areas including detailed wetland habitat classification, location mapping and boundary delineation;
- Identify and inventory fish breeding and spawning sites in leasable fisheries areas for possible establishment of additional protected areas;
- Facilitate knowledge transfer and provide assistance and training to less leaseholders on how to establish and implement new protected areas for fish spawning habitats;
- Improve law enforcement to combat illegal fishing and poaching in leasable fisheries;
- Explore alternative management approaches, such as community based management, where individuals cannot afford leases and/or where incidences of illegal fishing are high;
- Establish appropriate mechanisms and procedures for resolving water allocation conflicts between leasable fisheries and surrounding farmland;
- Monitor the effects of the 2011 sector reform on leasable fisheries productivity and management;
- Develop incentives for longer-term sustainability in lease management, rather than short-term financial gains;
- Analyse the efficiency of current stocking and feeding practices and revise government guidelines accordingly;
- Analyse the efficiency of post-harvest value-chains and identify entry points to provide technical assistance to leaseholders for improving practices and marketing strategies.

7.6 Mapping Hilsa and commercial fish migration and spawning grounds

Key Result

- The mapping of fish migration and spawning grounds of Hilsa and other commercially important fish species across the AD and CDZ has been highlighted by DoF as an important result providing new information on the location of breeding and migration sites for better management.
- The research design and method used local knowledge and represents an important collaboration between DoF and fishers and is providing the basis in which co-management can be developed.
- The research also represents a collaboration between DoF, WorldFish and FAO.

Discussion

The Hilsa and commercial fish migration study was co-funding with FAO / BOBLME[5] and provided information about the spatial and temporal distribution and migrations of *Tenualosa ilisha* and 20 commercially important fish species. The research design was led by WorldFish and the research planning and implementation by DoF's AWG on capture fisheries.

Three main migration routes were surveyed: Pathein River, Ayeyarwady River in the AD, and Ayeyarwady River in the CDZ. Thirty-two sites were surveyed between December 2013 and December 2014. Development of a migration study methodology used local fisher's knowledge for rapid identification of migration patterns and spawning sites.

The coastal zone shows a consistently high yield throughout the year except during the monsoon season. This zone is not characterized by juveniles but rather by adult fish. In the inland delta, juveniles are observed as well as large size individuals. The study indicates that the Ayeyarwady mainstream is the most important migration route to upstream breeding sites. However, the important contribution of the Toe River and Twantay Canal should be noted. It is the convergence of these three migration routes that likely contributes most to breeding and sustainability of the stock.

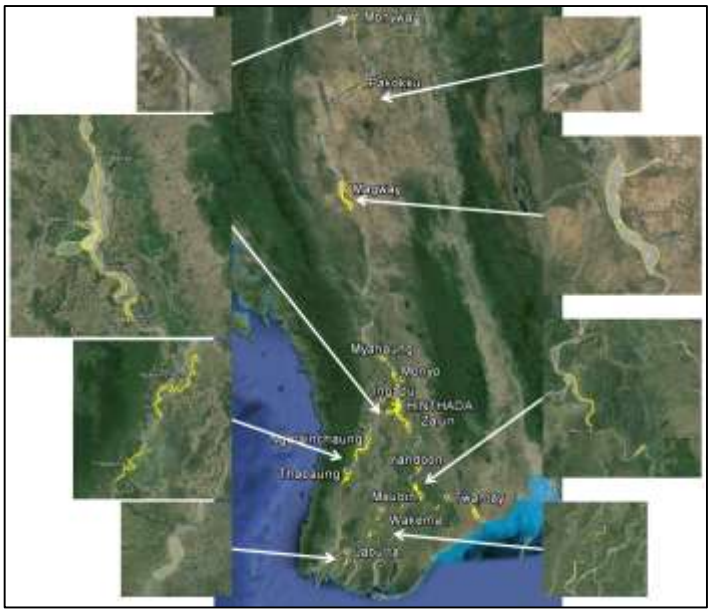

Figure 13: Distribution of Hilsa breeding sites along the Ayeyarwady system

Hinthada Township showed the highest ecological value from a fishery perspective, with spawning sites for 9 commercially important fisheries species with at least 28,000 ha of

[5] *Bay of Bengal Large Marine Ecosystem Project (BOBLME)*

breeding sites. Ingapu, Myanaung, Yandoon, and Twantay Townships Townships had the second highest ecological value and included breeding sites for 7 to 8 fish species. However, the size of breeding sites in these four townships is smaller than in Hinthada at between 1,000 and 8,000 ha. The third highest ecological value townships are Dedaye, Kalewa, Kyangin, Maubin, and Zalun characterized by a small area of breeding sites (2,300 ha).

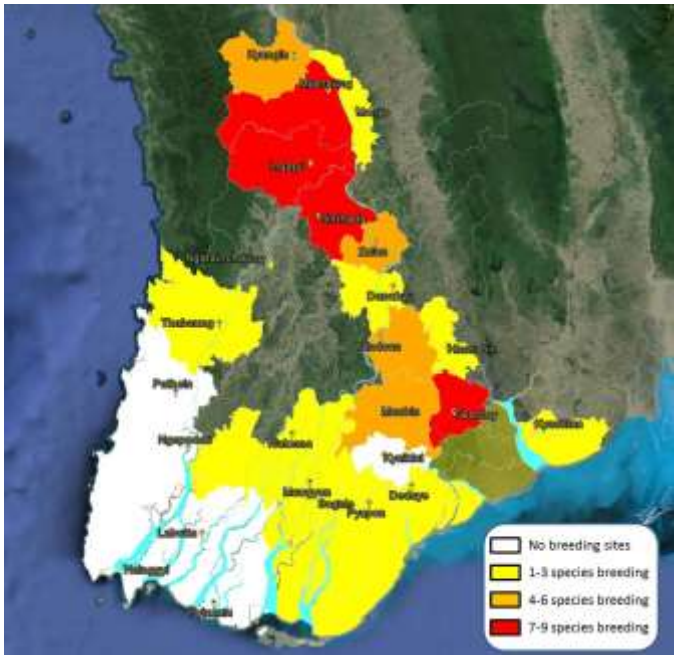

Figure 14: Breeding site concentrations across the Ayeyarwady Delta

7.7 Data gathering using digital tablets

Key Result

- MYFish introduced and tested a new methodology for collecting data using digital tablets that was applied through the AWG on capture fisheries for generating data on inland fish migrations.
- A paper was produced and presented at the conference of the Asian Federation for Information Technology in Agriculture.

Discussion

Fisheries Research Using Digital Tablets in Myanmar introduced a new method for data gathering in Myanmar using digital tablets in the field. The method was part of a fish migration study aimed at identifying migration patterns and breeding sites of key commercial fish species in Myanmar. The research findings were based on systematic and structured gathering of local knowledge along a 1,000km long segment of the Ayeyarwady River, from the southern AD to the northern CDZ. Digital tablets are used to convert local indigenous knowledge into data.

The system developed two modules: i) Android-based tablets with digital questionnaires for data collection on the field, and ii) a Back-Office application for questionnaire management and data compilation. The tool allowed data collected from different tablets to be uploaded through a ftp server and combined them into a single matrix ready for analysis. In addition, the survey software was updated in real time on the individual tablets. The system bi-passes the time-consuming manual data entry process and the data become available for analysis immediately after the last survey. The cost was similar or lower than that of manual data entry. Time and cost-efficiency along with road-tested reliability made this approach an effective one for field research in developing countries where there is good telephone network coverage.

7.8 Improving understanding of co-management potentials

Key Result

- The dynamic and changing complexity of inland fishery management through the decentralisation of laws and regulations to State and Regional Governments has meant that further research on the co-management potential was a priority;
- Additional information was generated on co-management in two studies providing data on different management practices that could be tested in phase two of MYFish.

Discussion

Research was carried out to look at existing fishery management systems for inland and coastal fisheries. One study was coordinated through the AWG for capture fishery and looked at the potential for community pond managed fisheries. A second study represented a collaboration with Smithsonian Institute to explore the economic opportunities in management of spiny lobster in Myanmar. The lobster research and program arrangements in Myanmar have been instrumental in developing a proposal to test different economic instruments in the management of Hilsa that has been successfully developed with the UK's Institute for Development Studies (IDS) with funding from the UK's Government's Darwin Initiative.

These two studies alongside the characterisation studies provide an important baseline of information on the potential for developing co-management and have contributed to the development of a second funding proposal to ACIAR (MYFish2) that is specifically target at testing and adapting inland fishery management.

Problems and potential for community managed culture fisheries

The study presented exploratory research on the opportunities and limitations for community managed culture fisheries (CMCFs) to provide benefits to the poor and vulnerable groups in Myanmar with a focus on governance. Primary data were collected from communities in the AD and CDZ and secondary data were used to assess the wider governance context. Supra-community and community level factors were considered. Community pond resources and their management differed between the two study regions: in the AD, most communities have at least one pond and used almost for drinking purposes; in the CDZ community ponds are predominantly used for agricultural uses.

The successful introduction of CMCFs that are sustainable and benefit vulnerable groups will require a multifaceted approach which develops supporting state and regional policy, addresses legislative shortcomings, improves accountability structures, secures community property-rights, increase community interest and builds capacity for community-based fisheries management. It is recommended that initial efforts should focus on a small number of case study communities to gain in-depth understanding and to act as exemplar CMCFs. As an exploratory study the paper does not intend to be conclusive, nevertheless as a novel area of research the findings provide an important insight to guide future research.

Recommendations for developing community managed culture fisheries

Community managed culture fisheries (CMCFs) have the potential to support food security and poverty alleviation objectives of rural development. Successful CMCFs will require context specific project design and changes in formal governance to compliment local level practices (Pomeroy 1995). A multi-strategy approach is needed to:

1. Develop supportive regional policy: Policies should provide mechanisms that recognise community organisations and community resource tenure.
2. Address legislative shortcomings: Local DOF should be actively involved in drawing up new union legislation to reduce the gap between written and implemented law; again these changes should favour poverty alleviation by recognising the importance of subsistence and small-scale fisheries.
3. Improve accountability structures: CMCFs should be used as a platform for promoting horizontal accountability within the Ministry of Agriculture, Livestock and Irrigation. The

DOF and DOI should be encouraged to actively work together to develop legislation and policies that support CMCFs.

4. Secure community property-rights: Prior to investing resources into a CMCF existing formal property-rights surrounding the pond resource should be clarified.
5. Increase community interest: Information on the design, required inputs and expected outputs of the CMCF should be made available to all households.
6. Build capacity for community-based fisheries management: Focus should be on the benefits of community management approaches, public participation, power distribution and representation of vulnerable groups for poverty alleviation and food security.

Economic opportunities in management of spiny lobster in Myanmar

The study was led by Smithsonian Institute and partnered with WorldFish to review the policy framework governing inshore fisheries in Myanmar. The study presented a case of the high-value mud spiny lobster fishery to illustrate how economic opportunities can drive management reform. Using reconstructed private-sector sales data with species biological characteristics a simplified static constant-price model was constructed to compare economic efficiency of the fishery in compliant and non-compliant states. A minimum capture size regulation exists for lobsters, but it is not species specific, and is neither complied with nor enforced, as fishers and buyers openly trade increasing numbers of juvenile lobsters. Reconstructed landings suggest that growth overfishing is occurring, with catch proportions of very small juvenile lobsters <100g increasing by 300% between 2011 and 2014. However, economic modelling suggests that in the current market state, enforcing existing minimum size regulations could increase fishery revenue by >350% by harvesting within an optimal size range. These results provide evidence for economic based approach to strengthening fisheries management and policy development of the lobster fishery in the socio-political context of Myanmar. Furthermore, the study highlights an opportunity to drive inshore fisheries management reform towards sustainability in the context of the new governance climate in Myanmar.

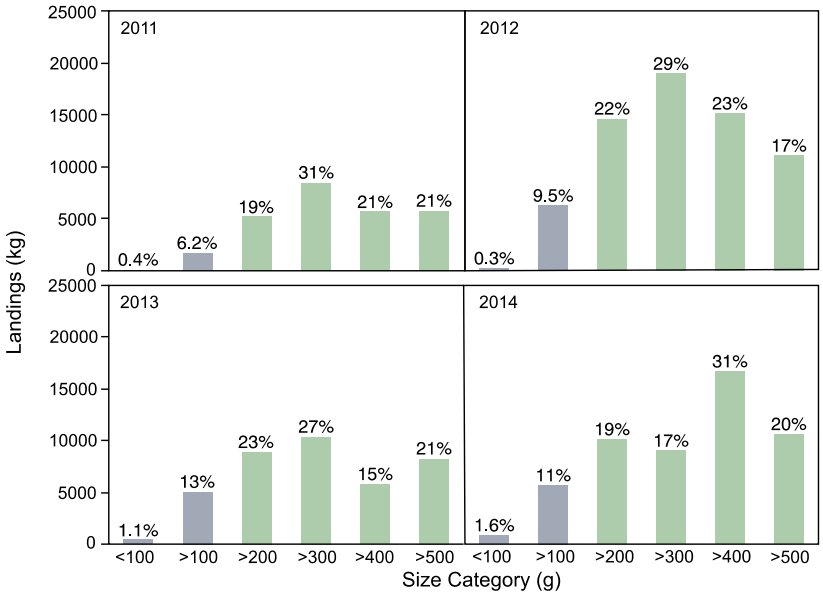

Figure 16. Landing weight (kg) per year by size category of *Panulirus polyphagus* purchased by one buyer in Myeik, Myanmar between 2011-2014.

Recommendations for using economic instruments for fishery management

- Reconstructed bio-economic data can inform fisheries management and policy development for the high value lobster fishery in Myanmar;
- Results suggest that for lobster, economic incentives fit neatly alongside biological ones, and that a functional minimum size limit would benefit all fisheries stakeholders;
- The study recommends a proactive collaboration between fishers, buyers and government to design new size regulations considering bio-economic data;

- A stronger partnership between the private sector and government would engage market segments and allow for the incorporation of economic approaches to control growth overfishing;
- The need for more enforcement is of importance, but will not work on its own. Proactive approaches that engage different stakeholders in management, particularly traders and wholesalers will ensure that fisheries legislation and management plans are invested in and upheld by fishers and traders, and face far higher chances of success;
- Given the current expansion of trade in the new governance climate in Myanmar, the potential gains to be had, combined with the resilience of lobster fisheries to exploitations, make this a potential platform from which to build a strategy for the future of Myanmar's inshore fishery sector.

7.9 Characterising and developing small scale aquaculture

Key Result

- The characterisation studies produced a comprehensive documentation by DoF WorldFish and FRDN of sector practices in small-scale aquaculture (SSA);
- The application of new knowledge to the development of SSA pilots and subsequent scaling of technologies to other development projects has resulted in the growth of a viable and sustainable SSA sub-sector in Myanmar;
- Highlighted in this section are the key findings from the household and community surveys (CDZ and AD) and study on commercial fish farming and potential for linkages between the large scale commercial aquaculture and small scale farmers.

Discussion

The characterisation of SSA has focussed on better understanding existing SSA practices and also understanding the relationships between SSA and commercial aquaculture. For DoF research staff, the research has helped to facilitate consultations across all administrative levels – from village to national levels and across the sector. The research methods have provided DoF with data on the rural livelihoods of fish producers, the identification and mapping of villages with potential for SSA development, and the identification of the main opportunities and challenges facing SSA development. The studies have been used to define the main agro-ecologies in the AD and CDZ that have been used to design and frame the pilot studies.

Small-Scale Aquaculture (SSA) - household and community surveys (CDZ and AD)

At the start of MYFish there was an absence of SSA information and limited government records or a database on SSA. There were no targeted investments in SSA, no testing of SSA technologies in rural communities, no private sector involvement in R&D, and aquaculture expertise within local institutions was poor with only a few NGO organizations involved in aquaculture (mostly emerging post-cyclone Nargis in 2008). Only a small number of households were engaged in SSA.

The rational for the SSA surveys was to characterise the existing aquaculture systems and to understand the key challenges and opportunities for further development. The research also looked specifically at gender. A brief description of the SSA systems used by farmers is provided in BOX 1 and in Figure 9.

In the freshwater region of the AD only 33% of ponds had year-round water, and a majority of ponds were rainfed. Comparatively, 78% and 100% of ponds in the seasonally and permanently-brackish water zones had year-round water and most ponds in these areas were fed by stream, creek or river. The most common system used was carp polyculture (50.7%). This was particularly common in the freshwater zone where farmers raised rohu with mrigal, catla and/or common carp, and occasionally also with tilapia. Carp monoculture in the Delta was dominated by rohu production.

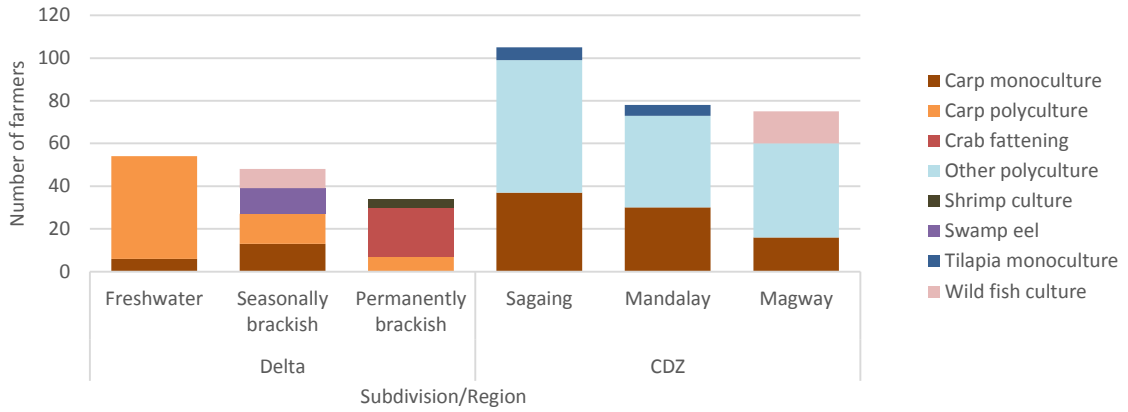

Figure 9: Distribution of SSA systems across the Delta and CDZ

Most fishponds in the CDZ relied on dam irrigation (77.1%), were seasonal (73.3%) and were earthen (99.5%). SSA in the CDZ was dominated by finfish production and culture of rohu and mrigal was dominant, with other groups accounting for less than 20% of stocked fish. Over half of households surveyed in the CDZ practiced polyculture (57.8%). Unlike other parts of Myanmar where carp polyculture procedures are well established, in the CDZ farmers reported stocking their ponds with any available fish seed. The most common combinations were those that included rohu with mrigal, pacu or tilapia. Over a third of households in the CDZ practiced monoculture (36.4%); of these households 88.3% raised rohu and the remaining 11.7% practiced tilapia monoculture.

Gender and SSA

In the AD, far fewer women than men were full-time fishers or farmers; women were more likely to be involved in small business. Overall, women contributed more to household chores than men. Women in the AD rarely had sole ownership of assets, many assets were jointly owned by male and female household members. Women also rarely had control over on-farm or off-farm incomes. Women's social networks and access to knowledge, information, credit and markets were all limited. However, women generally had greater access to financial resources from cooperatives than their male counterparts, whereas men had greater access to financial resources from NGOs. In 98.5% of households, it was stated that women had the freedom to start a business or to move for business. For a number of farm activities, including the use of aquaculture products, decision-making was carried out jointly between male and female household members. However, the selection of aquaculture practice was mostly made by males (71.3%). Women had less aquaculture knowledge than men. Although men play most major roles in aquaculture activities, women had extensive participation in all phase.

In the CDZ households reported that women and men had equal access to livelihood assets. Gender difference in income sources in the CDZ were identified through focus group discussions. Agriculture, livestock and aquaculture were the major source of income for male household members. Livestock and agriculture were also major sources of income for female members, along with small-scale vending and small businesses. Very few people were employed. The only livelihood activity that women were not permitted to undertake working on mosques. In all three agro-ecologies in the CDZ, both women and men were involved in aquaculture activities. Men were mainly involved in pond preparation, stocking, harvesting and partially in feeding activities, whereas women were mainly involved in feeding and marketing and occasionally in harvesting. Roughly one fifth of women were not involved in aquaculture activities.

Box 1. Small-scale Aquaculture systems

Carp monoculture – the most common species used in Myanmar carp monoculture are rohu and mrigal. Which are stocked at the rate of 12,000 - 20,000 fish/ha and harvested after 6-8 months when fish are roughly 200-300g. After that yearlings are stocked at low density (2500 fish/ha) to produce bigger size fish for filleting or whole fish export.

Carp polyculture – the most common fish culture system used in Myanmar (Edwards, 2005, 2009). There are 13 finfish species commonly produced in the polyculture systems and rohu accounts for a majority of cultured fish (FAO, 2012; DoF, 2012). Average production from polyculture systems is 2-5 tonnes/ha.

Crab fattening – Crab fattening is the practice of rearing small-sized mud crab (60-80g) to legally marketable size (>100g) in earthen ponds or small cages. Ponds are roughly 0.1 ha size and stocked with 600 - 700 crabs. Survival rate is about 60-80%. Fattening takes 7-14 days and farmers usually produce 5-15 crops per year.

Other polyculture – Stocking of any available fish raised using no established procedures.

Shrimp culture – both brackish/marine and freshwater shrimp species are cultured, using four key systems:

i) *Extensive plus (brackish/marine)* – hatchery-produced tiger shrimp post-larvae are nursed and fed in small ponds for roughly one month. They are then stocked to semi-intensive density of roughly 1.0-2.5 pieces/m^2 extensive trap and hold ponds. Supplementary feed is often provided to increase yields. The yield is 10-20% more than that of the traditional extensive trap and hold system.

ii) *Trap and hold (brackish/marine)* – during high tide wild tiger shrimp, post-larvae enter large ponds (4-40 ha) located along the coast and are trapped by the closure of sluice gates. There are no inputs; high tide occasionally tops up the pond water and restocks the pond. After 4 months, partial harvesting is carried out. Stocking density is estimated to be around 1-2 shrimp/m^2 and yield is quite low, at an average 125-250 kg/ha/year.

iii) *Freshwater prawn monoculture* – wild or hatchery produced freshwater prawn seed is stocked to a semi-intensive density of 5-7.5 pieces/m^2. Prawns are fed with locally prepared feed containing 25-30% protein. Complete harvesting is carried out after 6 months and average yield is roughly 1.0 tonne/ha. Monoculture of giant freshwater prawn was very common until the early 1990s but is now rarely practiced due to constraints of the need for high-protein feed and the aggressive and cannibalistic nature of mature males.

iv) *Prawn and carp polyculture (freshwater)* – Juvenile fresh water prawn of about 1 g size are stocked at a rate of 10-15 pieces/m^2 in carp grow-out ponds. No special feeding is needed for the prawn. Complete harvesting is done along with the carps after 6-12 months of culture with a yield of about 300 -500 kg/ha.

Swamp eel culture – a system promoted in the delta region by I/NGOs. Swamp eel are cultured in small, bamboo framed ditches/tanks partitioned to provide refuge and swimming habitat. Tanks are stocked with 15-30kg of baby eels and when harvested after 4-5 months, production is roughly 2-2.5 times this volume. Eel culture requires occasional feeding with trash fish. The sustainability of the system is dependent of the availability of feed and wild seed.

Tilapia culture – Tilapia is fast growing and has short life cycles. Small species such as Nile tilapia are suitable for small ponds. Tilapia culture is generally a commercial practice, although some small-scale farmers do stock wild tilapia seed.

Wild fish culture –homestead ponds are stocked through a temporary connection with a river (trap holding system) or using wild seed. Fish are occasionally fed and harvested when pond water levels are low. Common wild fish species include walking catfish, climbing perch, snakehead, mola and some high market value fish such sea bass and featherback.

Recommendations for SSA development

The successful development of SSA to support poverty alleviation efforts and improve food security in Myanmar will require multi-faceted efforts to provide the necessary infrastructure, resources and support:

- Nurseries for common aquaculture species should be established to ensure local access to affordable, quality seed and to reduce pressures on natural seed resources. Hatcheries and nurseries would also provide employment opportunities;
- In both regions feed mills should be introduced and better feed formulations developed using locally available products to provide high quality and affordable feeds;
- Financial support and subsidies for SSA systems from formal sources should be made more readily accessible to SSA farmers and landless groups to incentivise livelihood diversification and reduce debt cycles;
- Existing SSA farmers and those interested in the enterprise should be provided with training in best-practice management strategies, including species selection, stocking practices, inputs, multiple harvesting strategies and integrated agriculture-aquaculture systems;
- Research should be conducted to assess the most appropriate, profitable and sustainable technologies for each agro-ecology. This should include input from stakeholders and draw on the considerable knowledge base in other Asian countries. Adaptive on-farm trials should be used to test technologies;
- The initial focus of SSA development in the CDZ should be in irrigated areas where water availability is less of an issue. Ponds should be made deeper to increase their volume and extend culture periods;
- Government land and water use policy should be revised to promote SSA. The conversion of relatively small areas of rice fields to fish ponds would considerably improve the welfare of farm households and contribute national food security;
- The formation of farmers' groups and cooperatives should be encouraged to promote knowledge transfer, resource sharing and increase the accessibility to financial support.

Study of commercial fish farming and potential for linkages between the large scale commercial aquaculture and small scale farmers

An analysis of commercial aquaculture was undertaken with DoF, Solidaridad and Wageningen University (WUR) in 2014 to identify beneficial linkages between large and small scale aquaculture enterprises as recommended in the scoping and diagnostic exercise.

The study was carried out in the AD with a team of ten scientists, DoF and MFF staff. Mission activities took the form of visits to small and medium enterprises, large scale commercial aquaculture and feed manufacture sites (including pond based farms and cage culture operations), fish landing sites (jetties), a smallholder cooperative, feed mills, fish markets, an NGO-based small holder micro-financing operation, leasable fisheries and an experimental rice cum fish culture site, as well as DoF regional offices, DoF hatcheries and a DoF fish disease diagnostic laboratory.

The study highlighted an important constraint in the definition that distinguishes between the two sub-sectors and can impede SSA policy development. The study proposed a new definition that moves away from area-based terminology (i.e. small scale farms <1 acre of pond area; medium scale farms from 5 to 10 acres, large scale farms >10 acres) to a definition that incorporates use categorization. A new definition of small scale aquaculture in Myanmar proposed as:

> *family-based production of aquatic organisms where there is limited farmer investment in assets or paid labour, with farm labour provided predominantly by the farm owner and family members (men, women and youth), and where the farm produce is sold and/or used for household consumption.*

Conversely, medium to large scale aquaculture is defined as:

> *Commercial production of aquatic organisms where there is significant farmer investment in assets and paid labour.*

The study identified the following development activities that would support closer ties between these two sectors:

1. Mediate the formalization of a partnership between at least one large scale integrated fish production enterprise and small scale farmers by assisting to identify suitable product market combinations (PMC), develop a business case, design an administrative and operational framework for partnerships, and identifying minimum requirements (characteristics) of collaborating small scale farms.
2. Explore the potential for the establishment of small scale farm clusters or cooperatives with a view to improving productivity and incomes through collective negotiation on input costs and farm gate prices.
3. Undertake a review of targeted public sector policy options for supporting the establishment of SME-largescale aquaculture linkage, including extension support, tax credits and subsidies.
4. Explore potential for smallholder farmers to cater for potential niches in the domestic market that contribute significantly to sustainable food security, by developing PMCs that specifically target local markets, with a view to improving smallholder productivity and profits, as well as nutrition in local communities.
5. Undertake a study to examine the potential for encouraging SME-largescale aquaculture linkages (aimed at improving the profitability and sustainability of aquaculture small holders) through market mechanisms, including through recognition in certification systems (e.g. ASC, WWF, Fairtrade).

7.10 Piloting and testing small-scale aquaculture

Key Result

- DoF and the FRDN successfully piloted six SSA technologies in the AD and CDZ applying a combination of on-station trials and participatory 'farmer-field school' research methodologies;
- The approach has provided DoF with the tools to use research in development and engage producers and farmers in the research process;
- The research in development approach for testing SSA technologies has been adopted by LIFT MYCulture and EU MYSAP development projects and represents a significant investment in participatory research.

Discussion

The project piloted and tested small-scale aquaculture (SSA) in the AD and CDZ and employed participatory research methodologies. This approach enhanced development impacts and provided opportunities by engaging the people being researched (farmers, producers, women and youth) in the research process and encourages innovation, economic and policy development.

Eleven SSA technologies were identified during the scoping phase (Table 3) and six were tested or assessed by the project through the AWG and FRDN research modalities. The AWG applied on station research and pilot-tests within communities to engage hatchery managers and household producers in the research process and to address different practical challenges faced by the different SSA technologies.

Training was provided to DoF hatchery managers and producers on pond preparation, propagation, feeds and raising indigenous small species, nutrition, transportation preparation and distribution of fish to small and medium scale producers. Three government hatcheries were made available through the DoF partnership with WorldFish and were engaged by MYFish to strengthen capacities to breed and supply small-indigenous species (SIS) to SSA producers. The portfolio of low-cost technologies piloted included: reservoir cage farming;

pen culture; pond polyculture; rice-fish culture; and adapted eel culture. The research process continually improved SIS culture practices in order to produce improved quality fingerlings.

Table 3: Small-scale aquaculture technologies and their potential in the CDZ and Delta

	Technology	CDZ	Delta
1	Community fishponds	High	Medium
2	Integrated livestock and fishponds	Medium	High
3	Garden ditches (Chan Meow)	Low	High
4	Wish ponds	High	Medium
5	Trapping of wild fish form rice fields	Low	High
6	Aquaculture for supplementary nutrition	High	Medium
7	Rice fish culture	Medium	High
8	Cage and Pen aquaculture	High	Medium
9	Borrow pit fish culture	High	Medium
10	Eel culture	Low	High
11	Backyard hatcheries and nurseries	Medium	High

The key outputs of the SSA pilots were strengthened research capacity of DoF that was applied to continually improve the learning from the pilots and to build capacity of hatchery managers and producers in new SSA skills and practices. The pilots have helped DoF build their capacity to undertake systematic research to test SSA under different conditions and to develop solutions with producers.

The research in development approach for testing SSA has been incorporated into the proposals and project documents for two development projects that are scaling SSA technologies across the AD and CDZ. In 2015, the LIFT MYCulture project started scaling MYFish SSA technologies and techniques to over 10,000 rural households in the AD and CDZ. In 2017, the European Union (EU) SSA development project MYSAP-IN started scaling MYFish SSA technologies and techniques to a further 5,000 households in the upland areas of Shan State and Sagaing Region. Both projects have adopted the research in development approach for introducing and tested SSA and represents a significant investment in participatory research.

7.11 Demonstrating increases in production and income

Key Result

- The SSA results indicate that SSA production and incomes have been positively influenced by MYFish research, development and extension activities.
- Comparing data from the characterisation study as a baseline with the results from the pilots and scaled SSA technologies shows an increase in net production of up to 40% and incomes by 50% in some of the systems tested.

Discussion

The ACIAR program indicator for increase in productivity is articulated as ‘actual increase in productivity of target livelihood systems resulting from program interventions’ and applied to indicate an increase in production in the SSA technologies. The MYFish data used is taken from the SSA household survey, the pilot interventions and the scaling of MYFish technologies to the LIFT funded MYCulture project. The SSA characterisation survey designed and carried out by DoF, recorded average production yields in the AD for small carp monoculture, carp polyculture, swamp eel culture, mud crab, tiger shrimp culture, and wild fish culture systems. The results were: 378; 1,507; 633; 6,387; 254; and 546 kg/ha/year respectively. In the CDZ the average yields for carp monoculture, tilapia monoculture, polyculture, and wild fish culture system were: 2,120; 2,180; 1,880; and 1,790 kg/ha/year respectively. For capture fisheries in the AD, the average yield was recorded at 540 kg/year/fisher.

During the SSA pilot testing, a total of six production systems were tested (reservoir cage farming; pen culture; pond polyculture; rice-fish culture; and adapted eel culture). SIS seed

production was tested in three DoF hatcheries and one village-based feed production system was set-up and tested. Following the SSA pilots in 329 households (237 men / 92 women), between 2014 to 2016, most HHs (>200) increased production by a minimum of 10% during their initial cycle and some as much as 40%. The pilot tests in the AD for carp polyculture were calculated to be on average 2,000 kg/ha/year, a net increase of 600kg/ha/year or 40% from the baseline. For swamp eel culture, the pilot production was just under 900 kg/ha/year, a net increase of 250 kg/ha/year or 40% from the baseline. For rice-fish culture, the rice productivity was 3,000 kg/ha/year and fish production was on average 500 kg/ha/year.

A second production indicator for the MYFARM program is 'actual increase in cash incomes of rural households resulting from program interventions'. The SSA survey recorded actual gross income for producers in the AD for carp monoculture, carp polyculture, swamp eel culture, mud crab fattening, tiger shrimp culture and wild fish culture systems as: 438; 1,738; 2,889; 12,790; 694; and 546 $Usd/ha/year respectively. The CDZ SSA survey recorded gross income for carp monoculture, tilapia monoculture, polyculture and wild fish culture as: 2,773, 2,424, 2,421, and 2,962 $Usd/ha/year respectively. For capture fisheries in open water in the AD the gross incomes were estimated to be 850 $Usd/year/fisher. The SSA pilots in the AD tested carp polyculture, swamp eel culture and rice-fish culture and the gross incomes were: 3,000; 4,000; and 700 $Usd/ha/year respectively. For carp polyculture, the pilots had doubled gross income and for eel culture a 50% increase was recorded. The results indicate that SSA would provide on average gross income of 300 $Usd per household per cycle for a homestead pond.

7.12 Strengthening gender awareness in fisheries research

Key Result

- MYFish introduced and developed a gender strategy that helped the project and DoF mainstream gender in the research and development processes.
- The gender strategy has been extended to the fishery program of development projects managed by WorldFish in partnership with DoF
- The gender strategy is helping DoF apply and fulfil its national gender obligations

Discussion

MYFish with the support from the ACIAR program developed a gender strategy in 2014 that aimed to strengthen and integrate gender approaches across the project and program of work. The gender strategy mainstreams gender in research, M&E and organisationally and is influencing DoF to meet its gender mainstreaming goal.

The Gender aims were developed for each of the project objectives. For objective one, the aim is to enhance the productivity and diversity of livelihoods of poor women and adolescent girls in the fishery sector. Objective two, to strengthen mechanisms for gender mainstreaming in interventions that improve livelihoods and reduce poverty for women and their families. For objective three, to build capacity in R&D for DoF and project partners to integrate gender issues in their work; and to use systems and tools to generate gender disaggregated data.

Recognising that mainstreaming of gender into research, pilots and capacity building requires additional resourcing and capacity building, a gender post-doc was placed in Myanmar in 2015 to support the team implement the gender strategy and provided gender training for staff and enumerators. As well as producing gender disaggregated data the gender post-doc facilitated additional surveys with DoF and the University of Yangon to better understand the different roles of men and women and how they access resources. Gender research has been included in the SSA Survey AD/CDZ, migration study, M&E and in R&D training.

The gender approach has been adopted by the other development projects developed and managed by WorldFish and DoF including MYCulture, MYNutrition and MYSAP. DoF and University staff that have received gender training through MYFish are applying their new

skills to baseline surveys and qualitative assessment surveys. Organizationally, DoF is increasing demanding more gender inputs and is working alongside the gender post-doc to support the mainstreaming of gender across its activities and functions. This is a ministerial request to fulfil mainstream gender within the ministry.

7.13 Strengthening the awareness and understanding of the research outcomes

Key Result

- MYFish used the annual symposia to present AWG and FRDN research outputs and to convene discussions to identify current and future R&D priorities and to stimulate policy dialogue. An important result of these discussions was to build awareness how the research findings could be used and by who. Using an impact-pathway approach DoF and FRDN partners identified several pathways where the research findings could be applied to have impact. As a result, dialogue with DoF now includes a discussion about the users of the research findings and the impact pathways.

Discussion

To identify the outcomes of MYFish research, the national symposia workshop convened in December 2014 included an assessment of the impact pathways of the research findings and how the new knowledge and learnings can be enhanced and tracked. The meeting was held in NayPyiTaw with close to 100 participants involved including the DG, senior DoF staff, Minister and Deputy Minister.

The results of the discussion were used to develop an impact pathway for the research findings for capture fisheries, aquaculture and livelihoods. Summary tables from the workshop can be found in Appendix 4 and a narrative summary on the capture fisheries thematic presented below. An important output of the workshop using the findings of the capture fishery thematic has been the development of a second phase of MYFish (*Improving fishery management in support of better governance of Myanmar's inland and delta fisheries (MyFish 2)* FIS/2015/046 that started in January 2017.

Capture fisheries impact pathway

A key output of the impact pathway workshop was realisation that fishery and biodiversity assessments can be implemented through participation and the gathering of local knowledge from fishing communities. The end users of the research were identified as the fisheries communities and the expected change resulting from the research was better involvement of these communities in fisheries management. It was recommended that for implementing agencies, NGOs and research institutions as the next users of the research findings, will need to introduce tailored research methodologies and build the capacity of research teams to apply new participatory methods and approaches as the expected change.

For DoF and policy makers as the other end users of the research, research should be used to improve management and stock enhancement practices (expected change), and for fisheries communities (next users) to be better involved in the management of fisheries resources (expected change). For fish workers/ local and international NGOs (end users) to gain a better knowledge of fisheries resources (expected change), it was recognized that Universities/researchers (next users) should use applied research and development techniques to acquire more reliable fisheries data through these process (expected change).

The recommended way forward was to focus on studies that assess the biodiversity and management practices of Myanmar water bodies in collaboration with Universities, DOF and INGOs. Also for DoF and fisheries communities to work together to identify spawning grounds in the AD and to pilot co-management approaches. These recommendations have been used to shape the MYFish2 proposal.

7.14 Improving R&D capabilities resulting in new knowledge, skills and learning

Key Result

- Engaging DoF and the FRDN in MYFish fishery research has strengthened overall R&D capabilities to generate new knowledge on the sector and new skills that are helping to stimulate new policy dialogue in rural aquaculture and fisheries management. This is evidenced during discussions made at the final workshop when the results and outcomes of MYFish were discussed with DoF and FRDN partners

Discussion

In December 2016, MYFish convened a final symposia and workshop held in NayPyiTaw where different researchers presented their results and discussed the outcomes. Over 70 participants attended including the permanent secretary to the minister, the DG, senior DoF staff, regional and state DoF staff as well as project participants from the universities, private sector, NGOs and beneficiaries. The workshop aimed to provide feedback on what the sector considered were the key project results for MYFish.

The participants of the final closure workshop for MYFish held in December 2016 highlighted three main categories of results from the MYFish project. The first is new knowledge that the project generated on the sector. The closure workshop identified several areas where new information was produced and considered high value including: knowledge on the distribution of Hilsa and commercial fish migration routes throughout the Ayeyarwady River Basin and the mapping of breeding and spawning grounds; and data on the diversity and production of fish species in the rivers, leaseholds, irrigation canals and dams such as Sedawgyi Dam.

The second category of results came from gaining practical knowledge and skills. The closure workshop identified the work of the project on small-scale aquaculture (SSA) development as making a significant contribution to the sector and in particular providing skills on how to raise small indigenous small-species (SIS) in the DoF hatcheries through the training of hatchery managers who could now propagate and distribute new fish species to small and medium scale producers.

The third category of results was knowledge of the research process itself in terms of how to design projects and how to apply new methods to generate data that can address a research question or problem. The project closure workshop highlighted that more people were doing research and presenting research to their peers through the project symposia and also in other project fora. National researchers and scientists had also been exposed to research training in Philippines, Bangladesh, Indonesia, Thailand and Cambodia and had made international research connections.

The closure workshop acknowledged that the research outputs from MYFish represented collaborative approaches to science that had not been attempted previously and this had been successful in bringing together DoF with national Universities, MFF, NGOs, WorldFish and other international research institutions to do research. In addition, the studies and written reports produced by the project not only represented new information but had created ownership of the research and had helped to facilitate policy dialogue. The workshop acknowledged that the research outputs provided an insight into the level of scientific and research capacity across the sector, which was low and needed to be further strengthened.

7.15 Synthesising trends and challenges in inland fisheries and aquaculture

Key Result

- A synthesis of the main trends and challenges in inland fisheries and aquaculture has been produced using the characterisation and pilot studies and research carried out by other significant research institutions.
- This is helping both the international science community and DoF articulate the main challenges and opportunities facing inland freshwater fisheries in Myanmar.

Discussion

The synthesis of the trends and challenges for inland fisheries and aquaculture (1995-2015) is a review of the data and information from inland fisheries and aquaculture from the last 20 years focussing on the AD and CDZ was carried out by the project and included the research work carried out by MYFish and other significant international research. A synthesise publication was produced and included a historical review of production data for inland fisheries. Highlighted here from the synthesis is the poor accuracy and unreliability of official inland fisheries production statistics.

Like many other developing countries, Myanmar is characterized by a poor fisheries data collection system and also by official adjustments made to statistics (BOBLME 2014, Hosch, 2015). SEAFDEC (2012) explains that it is by the very nature of freshwater capture fisheries'- "small-scale, multi-species, multi-gear, involving a large number of fishers which are mostly part-time fishers, while the major parts of the fishery production are meant for household consumption" - that collection of what should be basic and routine data and statistics is very complicated. SEAFDEC (2012) further suggests that lack of accurate reporting from the inland fisheries sector means in turn that the sector is accorded a low priority by planners and policy makers in relation to other development sectors. The problem of underfunding, leading to poor data collection appears to confound the issue. This, reports SEAFDEC (2012), is the case across the whole of Southeast Asia, despite the crucial role that inland fisheries play in food security and poverty alleviation across the region.

Political reform and opening up to foreign investment have shaped changing incentives and motivation behind official fisheries statistics. Three distinct reporting phases can be observed.

Prior to 2000, there was limited incentive to assess and evaluate catch information and low catch volumes recorded during this period likely reflect a substantial under-reporting. For instance, inland fisheries in reservoirs and canals were not formally accounted for in official statistics. In his assessment of Myanmar inland fishery statistics from 1990-1999, Coates (2002) believed the reported annual catch of approximately 145,000 mt was underestimated by as much 2.5 to 3.8 times.

In 2000, the military government laid out a 30-year plan for fisheries development which included total fisheries production of 41.5 million metric tons by 2030, this equated to a 10% annual increase. Rapid linear growth observed in officially reported catch volumes preceding the plan are largely believed to reflect those targets rather than actual production levels (BOBLME, 2014).

Around 2013, the reporting issues of the second phase started to be identified. The engagement of the international community brought with it independent stock assessments and consumption surveys (Belton et al. 2015; Needham and Funge-Smith 2014; Krakstad et al. 2015). The findings of which indicated far lower production than those given in national statistics. The analysis of national household consumption data is particularly significant to Myanmar as inland capture fisheries provide about 75% of the fish consumed nationally. The consumption data indicate that actual catch is likely to be about half that reported by official statistics at around 600,000 mt per year (Needham and Funge-Smith 2014). The third and current phase is characterised by scrutiny of the reporting methods used in national statistics and concerns over the validity of official figures.

The first two reporting phases create a picture of fishery resources that shifted from relatively underexploited to increasingly overexploited. However, phase three highlights the unreliability of that picture, suggesting we know very little about actual trends and changes in Myanmar's fisheries. This creates unique development challenges. A priority for the sector must be to better understand the environmental and biological limitations to the countries fishery resources, as well as the fisheries management constraints that may contradict such optimistic plans for a 30-fold production increase over three decades. Developing better data collection systems and building partnerships with international expertise to improve data quality and interpretation are critical steps to ensuring the sustainable development of Myanmar's fisheries.

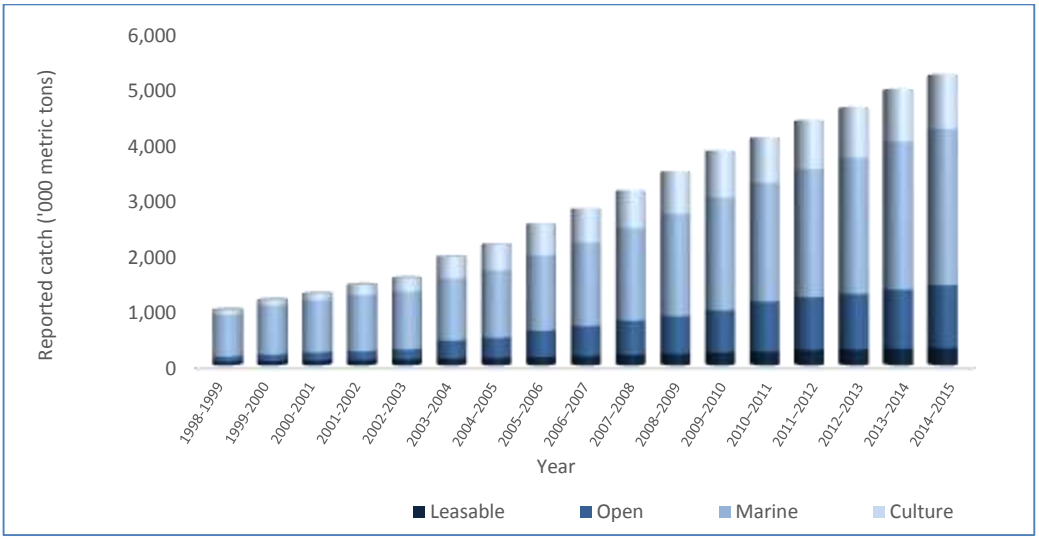

Figure 15. Reported production of inland leasable and open fisheries, marine fisheries and aquaculture from 1998-1999 to 2014-2015. Data from Oo 2010 and DOF 2015.

7.16 Building partnerships and science networks

Key Result

- The development of the FRDN as a science network aimed to encourage research collaborations between DoF and universities, private sector and NGOs, and placing DoF at the centre of the R&D and learning process in Myanmar fisheries;
- The FRDN has proved successful at facilitating collaborative research between national institutions and also at attracting international attention including research and donor interest and exchanges in fisheries R&D.

Discussion

The FRDN was established in 2012 by WorldFish and DoF as a fishery science network that would engage government with the private sector, NGOs and universities to design and deliver R&D projects. A national representative body was set-up in Yangon and successfully facilitated the development of a small research grant funding program and supported 22 studies between 2012 and 2015. The studies have contributed to characterisation of fisheries and the piloting of SSA technologies with the range of studies including; assessments of fish markets, fish biodiversity, livelihoods and the testing of low-cost aquaculture technologies.

The FRDN has played an important role in establishing cooperation between government and different sector institutions and organizations operating within the fishery sector and has functioned as a learning platform and stimulating technical and policy dialogue. The FRDN builds ownership, representation and engagement of national institutions and organisations in the research process that has been enhanced through international science collaborations.

The FRDN has been instrumental at attracting donor funding through LIFT for the MYCulture aquaculture development project. The FRDN modality has also been incorporated into the design and delivery of all projects managed by WorldFish that is attracting international research collaborations. These include ACIAR MYFish2, EU MYSAP, AQUA-ADAPT, WorldBank SOBA, and UK DARWIN-Hilsa.

The FRDN has become an integral part of the fishery program for WorldFish, placing DoF in the centre of the research and learning process, which has enabled DoF to work across the sector with many partners. Its continued success will require investment in the institutionalisation of the network within DoF and it is the aim of ACIAR MYFish2 to facilitate this through the Fishery Information Center with support from a full-time coordinator. This arrangement aims to link the research grants with national and international researcher, to sustain learning and strengthen national publications.

7.17 Funding mini-research projects

Key Result

- MYFish established the FRDN and used small-grant research funding and associated R&D capacity building interventions to strengthen national research capacities that engaged government, NGO, university and private sector in fishery research;
- The results of the mini-research projects have produced new information on fisheries promoting interactions across the sector and enabling policy dialogue through the hosting of annual symposia.

Discussion

The small-grants program was set-up to be facilitated through the FRDN and calls for proposals were made for both the AD and CDZ with a total of 22-projects funded. The organisations that have completed the studies include: Maubin University; National Shrimp Association of the Myanmar Fisheries Federation (MFF); Myanmar Crab Entrepreneur Association; Network Activity Group (NAG); Yangon University; Dagon University (two studies); Department of Fisheries Naypyidaw; Myanmar Business and Social Development (BuSoDev); Myanmar Consumers Union (MCU); Myanmar Marketing Research & Development (MMRD); and Shwebo Township MFF.

The results of FRDN and other significant research on fisheries were presented at four national symposia held annually by MYFish. The symposia provided a space to present and discuss new data on fisheries with the government technical staff and to engage senior DoF staff and policy makers in dialogue. Discussions involving the minister and deputy minsters included the prioritisation of research and impact pathways.

A sample of the findings from the FRDN studies are summarised below. The quality of the research was mixed, was mainly descriptive and with limited objective analysis. Increased capacity support was provided to encourage analysis and critical thinking and in particular to the Hilsa value chain study with Dagon University.

Trial of green water hatchery techniques in fresh water prawn *macrobrachium rosenbergii* (Myanmar Fishery Federation): The study involved trials of green water hatchery techniques in fresh water prawn, *Macrobrachium rosenbergii*. The purpose was to investigate the survival effect of chlorella on the larviculture of *Macrobrachium rosenbergii*. The study adopted the existing hatchery management protocols of *Macrobrachium rosenbergii* in Myanmar using 0.5 and 1.5ton fibre glass tanks during larval rearing. One 0.5-ton tank was without chlorella that served as control while the rest of the tanks had chlorella maintained at 200,000 - 300,000 cells/ml. This research was implemented at Aung Moe Khine Manufacturing Co at Kyauk Tan, for two cycle periods from June to September 2014. The study showed better survival of larvae provided with chlorella ranging 70% to 90% compared to 26% in control tank. These findings indicate the positive effects of chorella in Macrobrachium larviculture. Study recommendation is to use chlorella in Macrobrachium

hatcheries for better larval survival, complemented with better management of water and feeds to improve overall production performance.

Food consumption pattern of fisheries households (Yangon University): The study assessed the importance of fish and nutrition in the diet of fisher households in the AD, which might affect the growth of their children. The growth of the children was assessed by measuring their Body Mass Indicator (BMI). The result of BMI measurements from 885 children were 24.2% underweight, 67.2% healthy weight, 5.2% overweight, 3.4% obese, and 3.3% anaemic. Of the underweight children, 88.3 % have malnutrition. The meat consumed by children was very low (less than 50% of days and approximately 50 gm/meal). At least 12 kinds of meats were eaten, in which the fresh fish was the most consumed (45.2%), followed by dry fish (16.1%). Nearly 68 kinds of plant-based food consisting of fruits, tubers, beans and vegetables were consumed. Most underweight children were those from low education level where 26.2% were the children of fishermen and 25.5%, the children of causal labors suggesting that education level influenced food consumption styles. The results showed that undergrowth in children was due to insufficient food consumption or malnutrition. Moreover, the dirty water system for drinking was another factor contributing to unhealthy conditions of the fisher's children.

Socio-economic household surveys of fisher households (**MMRD):** Socio-economic assessment of 150 fisher households in six villages selected across three salinity gradients in the Delta. The survey provided a profile of two townships (Labutta and Bogalay) and covered the welfare metrics of poor fishermen households. The data indicates that poor fisher households struggle to meet daily food and essential household needs. Chronic food insecurity is common with 52% of households surveyed unable to meet daily food needs and 13 % relying solely on food from their fish catch and over 50% of households consuming half of the catch. Debt dependency is high and funds are used to provide food for their families with over 80% of the fisher households not owning land.

Livelihood household survey (MCU): Livelihood survey of 240 households of small-scale fishermen from four townships of Ayeyarwady Delta that focussed on income, living conditions, assets, expenses and education. The study concurred with MMRD on income and living conditions with a daily income ranging between 2,000 and 4,000/- Kyat / day (USD$2-4) and daily food insecurity experienced by 25% of households. Families with more than 3 children did not send all to school and usually the eldest daughters are sent to work at larger fishing firms to raise funds to buy fishing equipment. Health is a major concern with two out of 16 villages with a medical officer or midwife and respondents indicating limited knowledge on health and hygiene.

Fish resource availability assessment (Maubin University): the study surveyed three villages of Maubin Township to assess fish resource availability and income generating activities of three fisher communities. A total of 100 fisher households and 136 non-fisher households were interviewed to assess livelihood characteristics. Household information (housing materials, household composition, employment status, household assets), farming system, fishery, source of household income and access to financial services were recorded. Catch and effort of 100 fishermen out of a total estimation of 500 for the three villages were assessed. Catch size of total length, body weight, number of fish caught in respective species, catch weight, fishing time, fishing period and unit price of each catch were recorded. Set gillnet is the most important fishing gear for income generation, followed by long line fishing and eel trap.

Extent and potential of small-scale mud crab farming (MFF): Study of the extent and potential of small-scale mud crab farming in Laputta Township, Ayeyarwady Delta. Ten crab farming experiments were assessed in mud-ponds (0.35 ha in area) that were stocked with 1,000 juvenile crabs collected from the wild and harvested during grow out period of 120 days. Small fish and domestic waste products were used as feed. The return cost provided on average a total net profit of 1,080,625 kyats (USD$1,000) for each pond. The total stock weight was 440 kg and the final harvesting weight 935 kg. The study indicates the extent and profit potential of mud crab farming and importance for future management of mud crab resources.

Hilsa value chain assessment (Dagon University): The Hilsa Value Chain study was co-funding with FAO / BOBLME and providing a possible new modality for undertaking research though international collaboration and co-funding. The study was undertaken by Dagon University with technical backstopping and R&D capacity provided by WorldFish. The study focused on the economic aspects of Hilsa trade within eight villages in the Ayeyarwady Delta. The methodology was largely based on markets for the poor (M4P), mapping trade volumes, prices, governance and coordination on both high season (August to November) and low season (December to April). The study identified six main types of value chain actors and carried out 115 questionnaires in total.

In terms of production, catch volumes differ largely between high and low seasons. In the case of large scale fishers, the volume was reported to be five times higher in high season than in low season, while in the case of small scale fishers, volume differences can be as high as 40 times higher in the high season. Price per kg of Hilsa varies in function of both season and size of the fish. In both high and low seasons the initial price of the large-sized fish starts three times higher than that of small-size Hilsa, along the chain price increases differently according to fish size, small-fish mark-up reaches 100% between first and last point of sale, while large-size fish mark-up is less at average 80% between first and last point of sale. A comparison of average daily profit margins between the different actors shows that township traders take the highest profit as a result of the high volume they trade, especially in high season.

The study indicates that the value chain is working efficiently and there is a high demand for Hilsa with supply side management controls needed to control over fishing. Controls should consider economic instruments such as export controls during the low season alongside and biological controls during the high season to manage critical habitat and can combines data from the migration and livelihoods studies.

Hilsa fisher's livelihood assessments (MMRD): The livelihood assessment was *co-funding with FAO / BOBLME* and undertaken by MMRD together with DoF. Joint research planning meetings were carried out between Dagon University, DoF and MMRD at the beginning of the three studies to share knowledge and to identify sites and partners. The livelihood survey provides details of the profile of Hilsa fishers and their families. In the area of the study over 90% of fishermen catch Hilsa seasonally. Hilsa fishers are characterised into two types: (1) professional river fishers; and (2) subsistence river bank fishers. River fishers own boats and fishing nets and target Hilsa whilst river bank fishers mostly use bag net to catch smaller fish and shrimps as well as Hilsa that breed in the river banks. Hilsa 'river' fishers are considered better off compared with river bank fishers. The average income of the Hilsa fishers is 12,000 kyats per day which is four times higher than 'river-bank' fishers at 3,000 Kyats per day. Riverbank fisher families will sometimes skip meals due to poverty whilst Hilsa river fishers did not report this indicating income from Hilsa fishing is sufficient at least for food expenditures. A significant proportion of Hilsa fishers are migrant (34%) with the majority (81%) owning motorboats and nets. The dependency ratio of Hilsa fish income to Hilsa fisher families is high at 77% and focus group discussions indicated a concern over reduction in catches with unregulated coastal fishing boats catching high volumes of Hilsa before they enter into the inland river system.

7.18 Establishing fishery information systems

Key Result

- MYFish developed a fishery information system within DoF linked to the R&D Division that is used to store data digitally;
- An online digital library called the Fishery Information Centre (FIC) was set-up and launched in 2016 at DoF in Yangon that is provide open access to digitally stored data (dof.myanmar.fic@gmail.com)

Discussion

The storage of fishery data started at the beginning of the MYFish project and has been an ongoing process throughout the project and will continue into the second phase under MYFish2. The gaol is to develop a sustainable and enduring information systems within DoF that engages national research institutions in digitising and storage of historical and national research data and to use this to develop national researchers make their data accessible for future research and to support publications.

The task of digitally storing data was facilitated by DoF that set up a third AWG to oversee data input, storage and management. Equipment was purchased by the project to facilitate the establishment of the Fishery Information Centre (FIC) as a digital library located at DoF in Yangon.

The FIC is a digital database of research papers, project reports, informative posters and training books relating to Myanmar fisheries. By the end of project over 350 resources have been sourced from Government, Universities, the private sector and NGOs. The dedicated libraries AWG has been actively sourcing, cataloguing, and uploading all relevant resources on a server physically located within the DOF Yangon regional Office. Since December 2016 the server is accessible on a website (dof.myanmar.fic@gmail.com) in order to stimulate the development of an online science network where researchers can exchange resources and knowledge on the sector internationally.

The FIC partnered with national libraries and the cataloguing software was adapted from their existing digital collections so the FIC could further share catalogued resources within the existing databases. The AWG team received cataloguing training from the University Central Library (UCL) and the link with universities was established through the designation of a focal person from UCL in charge of promoting the FIC amongst students. In addition, the FIC partnered with FAO to provide its users with an access to their international fisheries and agriculture repository (www.fao.org/agora/en/). Such access to FIC users is only provided through dedicated library desktops in DOF but the FIC team is acting as a node between Universities and FAO to facilitate access throughout the country.

Table 4: List of digital stored data in the library - December 2016

Type	Quantity
Books	36
Journals	131
Laws	11
Poster	8
Proceeding	25
Project Reports	62
Training	27
Theses	56
TOTAL	**356**

7.19 Scaling MYFish outputs to new donors and new R&D projects

Key Result

- The scaling of proven technologies and techniques has been an important development goal for the project that WorldFish and DoF have pursued through additional funding levered through the promotion of MYFish results and outputs;
- Almost Usd$10M of R&D funds have been raised from the scaling of MYFish outputs with additional project and donor funding coming from Livelihood and Food Security Trust (LIFT) and European Union (EU) for aquaculture development, and ACIAR, World Bank, Darwin Initiative and UNFAO for capture fisheries;
- The impact of scaling MYFish SSA outputs to LIFT and EU development projects is estimated to be worth AUD$5.9 million annually in new fish production by 2019.

Discussion

MYFish technologies and techniques have been scaled to a number of development projects and donors, which have adopting many of the R&D modalities developed under MYFish. In 2015, Usd$3.3 million was awarded by LIFT for a four-year project to scale MYFish SSA technologies and techniques to farmers in the AD and CDZ. In 2017, USd$3.0 million was awarded to WorldFish and DoF by the European Union (EU) for SSA development to upland areas of Shan State and Sagaing Region.

Additional funding from ACIAR has been approved for a second phase of MYFish (2017-2020) valued at AUD$2.6M to focus on inland fishery management. Also, funded by ACIAR is a AUD$2.6M 4-year R&D project (2017-2021) to improve rice-fish production systems implemented with the International Rice Research Institute (IRRI) that builds upon SSA pilots tested under MYFish. These four projects are applying the modalities of MYFish to establish a network of capture and aquaculture R&D interventions in the AD and CDZ that are linked to DoF and the fisheries sector and has fully operational partnership arrangements.

The projects set-up is attracting the interest of other international research collaborations including a 4-year (2017-2021) regional climate adaptation project called AQUADAPT coordinated by the Unit for Social and Environmental Research, Faculty of Social Sciences, Chiang Mai University (USER-CMU). The outputs of the Hilsa mapping study has attracted the interest of the Institute of Development Studies (IDS) and a 3-year (2017-2020) project has been successfully funded by the UK Government funding through its Darwin Initiative. The World Bank is funding the Ayeyarwady Integrated River Basin Management Project and has awarded WorldFish / DoF to assess fisheries ecology and biodiversity applying and will apply the same research methods developed by MYFish and AWG capture fisheries group.

The scaling of SSA technologies through the LIFT and EU projects is estimated to benefit 15,000 rural households by 2019, approximately 60,000 people, and will be worth an estimated AUD$5.9 million annually in additional fish production.

7.20 Providing long-term program support and institutional commitment for fisheries R&D

Key Result

- ACIAR support to DoF (2011-2021) represents a 10-year commitment by the Australian Government to Myanmar fisheries development. Coupled with the funding from the LIFT, EU, WorldBank and UK Government this is helping to build a long-term program of support;
- The success of MYFish has led to a commitment by WorldFish to develop a country program office and for Myanmar to become a focal country for the FISH CGIAR Research Program (CRP).

Discussion

A key advantage of MYFish was timing. Myanmar and the fishery sector had been closed to international collaborations until the new reform government in 2011 when MYFish was initiated and could take advantage of the desire by the new government to address poverty reduction through rural agricultural development.

ACIAR's commitment to fund government and the design of MYFish that embedded the project in DoF with the provision of an operational budget fort DoF meant that dialogue and trust could be quickly established with DoF. The project gaols and activities were well aligned with DoF and WorldFish's development and research priorities and quickly started to present ecological and socio-economic data on capture and aquaculture fisheries from the scoping.

The project took a broader sector approach that engaged large numbers of different partners from government, private sector and civil society involving them directly in the research process through the FRDN. The participatory nature of the research helped to share ownership of the results. The subsequent discussions with DoF, MFF and NGOs meant that priority research areas where development interventions were needed could be more easily identified and agreed collectively.

The project's excellent and regular communications with DoF at high levels meant that longer-term development strategies could be articulated and could be demonstrated with a series of immediate and tangible outputs that built trust in the outcomes and helped to facilitate support for longer-term development needs. This was evident with aquaculture development for small-scale producers.

Building upon the agreement between DoF and WorldFish to facilitate MYFish and the positive dialogue and relations with donors across the sector enabled WorldFish to agree to planning for a long-term institutional commitment to Myanmar. WorldFish was cognisant that the outputs of MYFish and scaling interventions could be used to develop a program of science and research that supported the global strategy and would justify long-term institutional commitments to national and international research and multiple CGIAR engagement. A 10-year country agreement with WorldFish was developed and ratified by the Minister of Fishery, Livestock and Rural Development in December 2015 and incorporated into the agreement the R&D approaches and modalities developed by MYFish to build sector capacity of DoF and the FRDN. The country agreement institutionalises and commits WorldFish to work in partnership with DoF and to support institutional development and collaborations until 2025.

7.21 Providing technical support for planning and policy development

Key Result

- MYFish engages and interacts at a high managerial and policy levels with DoF and the ministry, and has built positive relations through regular communications with senior managers and policy makers. As demand on the sector from international investments grows, DoF and ministry are increasingly seeking support and guidance from WorldFish to apply program planning.
- As a result of the interactions and technical advice, it has been possible to secure and build awareness within DoF and ministry to support the policy uptake of MYFish and other projects outputs and outcomes.

Discussion

MYFish had daily contact with DoF staff, monthly staff meetings with DoF, and bi-monthly meetings with the DG and senior DoF staff in NayPyiTaw. During the reform government period (2011-2016) quarterly meetings were convened with the Minister and / or the Deputy Minister, and annually the project held a research symposium attended by all levels of government and partners. As a result, policy dialogue with DoF became increasingly easier and the interactions between MYFish and DoF more open and diverse as confidence grew.

Important contributing factors were: (1) the political changes in the country and the Government's policy to support the rural sector; (2) increasing acceptance of international agencies as development partners and; (3) the project's performance with valuable contributions in line with the policy and interests of DoF and Ministry.

The findings of the AWG and FRDN field trials particularly the SSA innovations were closely followed by the Ministry particularly the Deputy Minister (2012-2016) who was interested in the scaling opportunities. Research on cage culture in reservoirs showed economic potential and helped to establish policy dialogue to explore new revenue streams for regional government through legalizing reservoir fisheries. The growing evidence of the positive impact of SSA also resulted in DoF providing access to MYFish to three DoF hatcheries to undertake research. The access to hatcheries was extended to the LIFT MYCulture project, which by the end of 2016, the fishery program had access to a total of five DoF hatcheries.

MYFish became increasingly relevant and the Ministry strongly advocated support to small-scale fisheries for poverty alleviation and rural development. The Ministry and DoF endorsed the importance of 'rural' aquaculture as an instrument for poverty alleviation. Increasingly, DoF researchers attached to the project through the AWGs were asked to present their findings to policy makers. In October 2016, the AWG on capture fisheries presented the Hilsa migration study to the Ayeyarwady Regional Parliament creating an important dialogue for reform of the inland fishery law for better management of this economically important fishery.

The location of the MYFish office resulted in regular visits by all existing and potential donor and implementing partners interested in investing in fisheries. In 2014, the project provided guidance to the Danish Embassy and undertook a scoping for project formulation. This prompted discussions between DoF and WorldFish to support programmatic planning of the existing and pipeline projects. Figure 17 was created in 2014 when there were less than 10 investors in fisheries. Today, the number of project investments engaging DoF is over 40. Managing the growth of the sector investment including human resources capabilities is a priority for DoF. Following this analysis and scoping, DANIDA have negotiated an investment of Usd$30M in coastal co-management and is supporting an important gap in fisheries development in Myanmar.

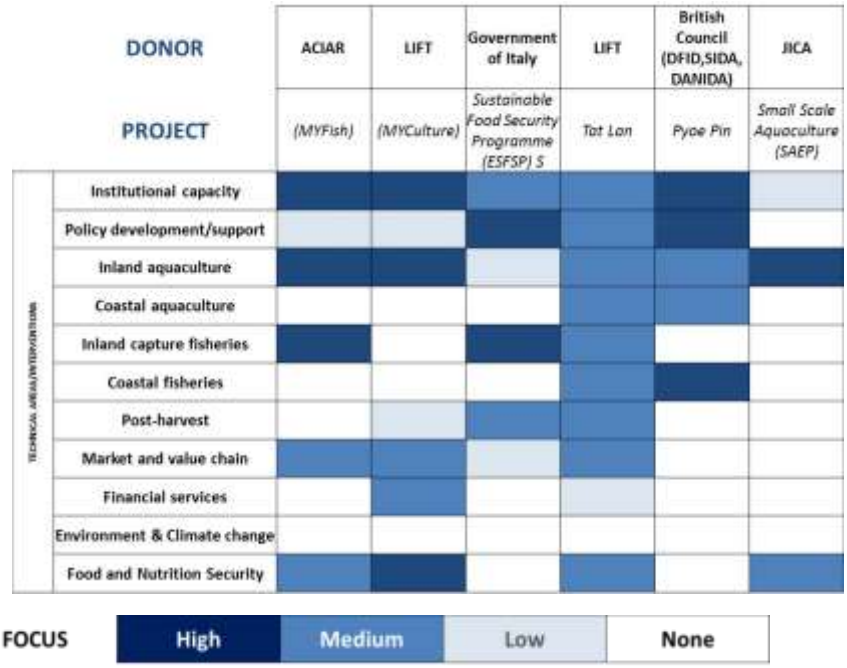

Figure 17: Programmatic planning for DoF of existing / pipeline projects in Myanmar 2015

7.22 Facilitating policy advisories and forming the Myanmar Fisheries Partnership

Key Result

- With additional funding from ACIAR, the MYFish team brought together Myanmar's leading researchers and practitioners on fisheries and aquaculture with international expertise to produce policy advisories in April 2016. The aim was to present a summary of current knowledge and understanding of the fishery sector for the new Government and new Minister. As result, the policy briefs have been used extensively by DoF to promote fisheries with new investors and within the new Ministry.
- An important output from the process is the formation of the Myanmar Fisheries Partnership (MFP) a coalition of national and international organisations that is working with DoF to support sector development and investment.

Discussion

Communicating policy outcomes on fisheries to the new government was identified as an important priority after the change of government in 2016. This was seen as particularly important after the Ministry of Livestock, Fisheries and Rural Development was integrated with Agriculture to become the Ministry of Agriculture Livestock and Irrigation (MoALI), and loosing fisheries in its name.

Building upon MYFish profile, DoF agreed to support a policy writeshop and with additional ACIAR funding through a small-research activity grant (*Developing fisheries and aquaculture reviews on Myanmar's fishery sector* FIS/2016/002), the MYFish team brought together Myanmar's leading researchers and practitioners on fisheries and aquaculture together with international expertise. The writeshop facilitated an assessment and evaluation of the fishery sector and identified the key drivers of change and the opportunities and challenges facing fisheries and aquaculture. The output was a collective analysis and synthesis of the sector using the best available data and has produced five policy briefs on the offshore, inshore, freshwater, aquaculture and overall fisheries sector.

The policy briefs provide a summary in English and Burmese of the current status and policy recommendations for fisheries and aquaculture. A summary is presented in Table 5 below. The policy briefs were presented in a seminar to the Ministry of Agriculture Livestock and Irrigation (MoALI) in June 2016 attended by the Permanent Secretary, Director General and senior DoF staff and resulted in a broad consensus and mutual understanding between the international participants and local NGOs with DoF on the key challenges and opportunities facing the sector and the ways forward.

An important outcome of the witeshop and producing the policy briefs is the process has helped to facilitate the formation of the Myanmar Fisheries Partnership (MFP). The MFP is a coalition of national and international organisations that has come together to assist the new Myanmar Government strengthen effective collaboration for the sustainable development of the fisheries and aquaculture sector. The MFP has emerged through a series of interactions at Regional and State Government levels to look specifically at fishery governance but will likely broaden its remit as other investors and implementing agencies participate.

Table 5: Policy brief summaries for each sub-sector of the fishery in Myanmar

Sub-sector	Summary assessment and next steps
Off-shore	Myanmar's offshore fish stocks have been depleted by up to 80% since 1979, exposing Myanmar's people to significant economic, food security, nutrition and environmental risks. This ecosystem decline has been driven by out dated and weak laws and policies and by inadequate management and institutional capacity. Investment in protecting and restoring fish stocks, ecosystems and habitats is required. The offshore policy brief describes how Myanmar's fisheries can be rebuilt and long-term economic, social and environmental benefits gained for the benefit of Myanmar's people by focusing on improving laws, policies, partnerships, management and institutional capacities. **Key messages** • Stocks are depleted and require rebuilding plans and partnerships. • Integrated, ecosystem-based and spatial approaches can improve management. • Sustainable offshore fisheries can support economic development, jobs and food security. • Policies and laws can be modernized to manage offshore fish stocks effectively. Institutional reforms can unlock the full potential of offshore fisheries.
In-shore	Myanmar's inshore fisheries support the livelihoods of millions of Myanmar citizens living in coastal areas. However, in recent years, the capacity of these fisheries to support viable livelihoods and contribute significantly to local economies has come under threat. The inshore policy brief sets out five priority areas that need immediate attention if coastal resources are to recover to more productive levels and if fisher communities are to continue to benefit from these resources. These actions must be aligned with key development principles including working through partnerships, promoting co-management and striving for greater gender equality. **Key messages** • Management of inshore fisheries resources can be improved. • Improved information and statistics on inshore fisheries management can be collected. • Laws and policies affecting inshore fisheries can be harmonized. • Coastal communities can be strengthened and fisheries-based livelihoods safeguarded. • Closer alignment of Union and state/regional level agencies and institutions can improve inshore fisheries management and law enforcement
Fresh-water	The freshwater fisheries in Myanmar are economically significant and important to livelihoods and food security. Yet significant threats to the resource base and public demand call for the development of management initiatives, legal adjustments and a people-centered approach. The freshwater brief identifies a series of options and priorities that could help improve freshwater fisheries management towards a more sustainable and equitable exploitation of inland fish resources. These include better knowledge of the resource base; integrated land and water management; the creation of opportunities through emerging Region/State legislation; the improvement of existing capture production systems and the development of new fish production systems. **Key messages** • Better knowledge about the fishery resource base is needed to ensure its sustainable exploitation. • Integration of agriculture, irrigation and fisheries under a single ministry is the opportunity to address conflicts and help integrate land/water management. • The new legislation can improve the contribution of fisheries to food security and livelihoods at the State/Region level. • Existing fish production systems (open fisheries, leasable fisheries) can be improved, in particular through co-management, for greater sustainability and benefit sharing. • New fish production systems such as irrigation reservoirs can be developed.
Aqua-culture	Fish is an extremely important component of the Myanmar diet, and demand is growing quickly as the country urbanizes and incomes rise. Aquaculture is ideally placed to meet this demand, while also raising farm incomes and creating employment. The aquaculture brief identifies three sets of policy options that could help to unlock the full potential of aquaculture's contributions to rural growth and national food supply. These are: regulatory reforms that allow small farmers to use their agricultural land for aquaculture; improved access to farm inputs and technologies; and greater access to the knowledge and services needed to support sectoral modernization. **Key messages** • Aquaculture in Myanmar has massive potential to raise rural incomes and meet domestic and global demand. • A competitive aquaculture sector led by small farmers and small and medium-sized enterprises (SMEs) can best generate employment and stimulate rural growth. • Allowing farmers to choose how to use their agricultural land is key to unlocking the sector's potential. • Farmers need the support of responsive input suppliers as well as knowledge and information service providers to diversify and modernize production. • Government action is needed to improve regulatory frameworks, strengthen institutional and human capacity, and build core physical infrastructure.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The impact of the changes in scientific practices resulting from the project are divided into three key areas: (1) applying new research practices to generate new knowledge; (2) using new scientific knowledge to improve fishery development; and (3) using new science practices to create platforms for science-based collaborations.

The science impacts are illustrated by the Hilsa study mapped the migration and spawning patterns of Hilsa in the Ayeyarwady River Basin and by studies undertaken on small-scale aquaculture (SSA) that characterised aquaculture opportunities and challenges in the AD and CDZ.

New research methodologies were used to collect data in the Hilsa study through the participation of fishers in mapping catch data and by DoF researchers recording results using digital tablets. The study findings mapped the location of Hilsa migrations and spawning grounds along the Ayeyarwady River and included 12 other commercially important fish species in the survey. The data was presented in one document that provided DoF with new scientific information and was used as evidence for improving inland fishery management in the AD. The study findings were presented and consulted by R&D division of DoF to the parliament of the Ayeyarwady Regional Government during the reform of the inland fishery law in 2016. Subsequently resources have been mobilised by the regional government with funds from LIFT to test co-management in the areas where fish migration and spawning were identified.

The SSA research findings and recommendations made by the project have resulted in a series of commitments by the Ministry to invest staff time and infrastructure resources into SSA development. The research methodologies used on-station pilots to test new treatments and species and this approach have been extended to five DoF hatcheries in total from the three originally supported by MYFish. The research practices used to test and adapt SSA technologies have been adopted by other donors investing in SSA such as the LIFT funded MYCulture and the EU MYSAP-IN projects. Both projects have invested in research practices developed by MYFish to systematically test SSA pilots in new areas of the AD and CDZ. The farmer field school approach that engages producers in the research process has been adopted by the LIFT and EU projects and the practices extended to NGOs supporting both projects and involving producers in the monitoring and recording of production data.

The findings of the Hilsa and SSA studies have been presented by DoF at various meetings that has stimulated science-based collaborations. DoF presented the migration study findings to the World Bank Group during an environmental impact assessment in 2015 for new navigation routes in the Ayeyarwady River. This resulted in DoF's participation with WorldFish in an assessment of the Ayeyarwady Integrated River Basin Management project that has applied the same data collection methods developed by MYFish. The Hilsa results were also presented at a regional Hilsa management workshop convened by WorldFish in Bangladesh and this resulted in a joint research proposal developed with the Institute of Development Studies (IDS) for UK Government funding through its Darwin Initiative. The study aims to build upon the methods and research findings of DoF's AWGs to pilot new management approaches using economic instruments. The Hilsa study was also highlighted at the 2015 impact pathway workshop convened by the project where cross sector working groups recommended using participatory methods in fishery and biodiversity assessments to systematically gather local knowledge and increase the involvement of communities in fisheries management as the end users of the research.

The research approach applied to SSA development has been presented by WorldFish and DoF to the Myanmar Fishery Partnership (MFP) and attracted the attention of other research institutions. Chiang Mai University together with Michigan State University (MSU) have developed a regional research proposal for a study called 'Climate Adaptation and Innovation

in the Aquaculture Sector of the Mekong Countries' that involves Thailand, Cambodia, Laos and Vietnam. The project is planning to engage DoF and Yangon University to carry-out research on SSA interventions to pilot SSA adaptions using participatory methods and building upon those developed by MYFish.

Impacts anticipated in 5-years

The anticipated science imparts across the fishery sector are:

- DoF has strengthened R&D capacities and is using MYFish based research methods to monitor production and incomes of producers and fishers that apply indicators of food security, nutrition and gender equity; and
- The Fishery Information Centre (FIC) is the largest repository of scientific information on fisheries and aquaculture in Myanmar and used by national and international Universities and research institutions to stimulate research collaborations and bolster peer reviewed scientific publications.

The anticipated science impacts in aquaculture are:

- DoF will continue to produce new knowledge on the SSA sub-sector and strengthen its R,D&E capacities by applying farmer field school methods to sites in the upland areas of Shan State, the CDZ and AD;
- Increasing number of investors in aquaculture will support DoF undertake on-station research to diversify knowledge and explore the potential of new species; and
- Scientific data and local knowledge will be used to adapt aquaculture practices in upland and coastal sites creating new knowledge and information.

The anticipated science impact in capture fisheries builds upon the characterization studies of MYFish and these will be fully realized during the second phase of investment by ACIAR in MYFish2 (2017-2020). The expected science impacts are:

- Scientific methods will be developed for DoF to characterise and describe site-specific ecological and social aspects of fisheries management arrangements;
- DoF has the capacity to assess the performance of different management strategies against fisheries management goals; and
- New knowledge will be generated on fisheries ecology, production and the distribution of benefits from fisheries resources.

8.2 Capacity impacts – now and in 5 years

The impacts resulting from changes in knowledge and skills resulting from the project are divided into two key areas: (1) capacity impacts through participation in project R&D; and (2) capacity impacts using the new skills and knowledge outside of the project scope.

The acquisition and application of new skills and knowledge has been facilitated through the two research modalities, the activity working groups (AWGs) established within DoF and the fishery research and development network (FRDN) that has engaged universities, private sector and NGOs in research across the sector. In the absence of a fisheries university or training college for fishery R&D and extension, the project has used the AWGs and FRDN modalities to enhance the knowledge base on fisheries R&D among DoF officers in general and the AWG researchers in particular. Almost 500 people (DoF officers, partner staff and beneficiaries) have been engaged in the MYFish research processes either through formal training, seminars and on-the-job capacity building developed by MYFish and contributing to research design, data collection and analysis.

Feedback from the closure workshop in December 2016 highlighted that the knowledge for conducting research is more advanced as a result of the project. DoF and partners know more about research methods and how to apply and modify them. The closure workshop agreed that the three national symposia, where over 60 presentations of fisheries and aquaculture research were presented to peers, provided the sector with the format and forum to continue to share information and debate fisheries development with key sector

institutions. Evidence of joint research from the symposia came from DoF in Monywa and Yinmarbin Districts in the CDZ that designed a research project for FRDN small grants program with Mandalay University to compare fish resources between leasehold and open access fisheries. Also, Monywa University collaborated with the Myanmar Fishery Federation (MFF) and DoF in the CDZ to assess different fishing gear activities in leasehold fisheries.

International training and exposure visits to the Philippines, Bangladesh, Indonesia, Thailand and Cambodia have built knowledge and capacity in DoF and Universities. The establishment of a FishBase node in Myanmar was facilitated by the project through collaboration and training with researchers from the Philippines (www.fishbase.org). The node has enabled staff from universities and DoF that have been trained in the open-source database to update information on Myanmar fish species. Since the initial training in 2013, the group has been active gathering and uploading biology information and in 2016 FishBase created a Myanmar language interface that was developed by the project.

The impact of the science outputs has been bolstered by translating principal research documents into Burmese for better accessibility and distribution. To ensure more “enduring” scientific information sources, the publications have been published through the national libraries initiative assessable through DoF’s digital library, the Fishery Information Centre (FIC). Several of these documents have been issued with a publication number provided by the Ministry of Information to DoF so the reports can be referenced and accessed online.

The Myanmar policy briefs provided the first synthesis of the fishery sector using an expert panel of international and national experts and using data from government, NARS, private sector and NGOs. The briefs have been used by DoF to provide visiting scientists, practitioners and policy makers with an overview of the fishery sector and options for improving its environmental, economic, and social impacts.

At the national level, there is strong political support for SSA development that has been championed by MYFish. The Government’s commitment is demonstrated by allocation of resources from its hatcheries for R&D with a particular focus on developing small-indigenous species (SIS) technologies and has been strengthened through collaborations with Bangladesh expertise that have shared SIS know-how with DoF hatchery managers and staff. Hatchery managers are critical to the development and extension of SSA in Myanmar and through MYFish three DoF hatcheries have produced and tested SIS for distribution to surrounding small-scale producers. This has since been expanded to a total of five hatcheries with additional inputs from the LIFT funded MYCulture project.

Extending the knowledge and skills beyond the project scope is evidenced by the integration of the AWG and FRDN modalities within the SSA development projects - LIFTs’ MYCulture, IFAD’s MYNutrition and the EU’s MYSAP-IN. The modalities and approach were adopted by the donors and also by DoF that have appointed DoF staff to the aquaculture program and not to individual projects. This has deepened the institutional collaboration between DoF and WorldFish facilitated by long-term investment in the fishery sector by ACIAR.

The two research modalities have provided a learning platform and has helped to nurture science-based network that has created links to the international scientific community. The approach has made it possible for the project to support five interns from Columbia, Beijer, Wageningen, Miami and York Universities that have provided technical inputs on nutrition, aquaculture, value chains and participatory research methods engaging DoF and partners via the AWGs and FRDN.

Impacts anticipated in 5-years

The anticipated capacity impacts across the fishery sector are:

- The FRDN is institutionalised within DoF and is supporting science networks that can design collaborative research with national and international researchers with members actively involved in establishing research priorities and dividing research responsibilities based upon individual capacities, resources and expertise; and
- Regular collaboration and information sharing between government, universities, NGOs, and private sector leading to better policy design and implementation.

The anticipated capacity impacts in aquaculture are:

- Adaptive capacity and learning is enhanced across the sector to address climate risk through scalable SSA systems, technology packages and best practices that have been developed and tested by DoF and FRDN research partners; and
- Increased sector capacity to implement fish breeding programs (SIS, GIFT tilapia, Rohu Carp) with public-private partnerships representing DoF and MFF established and managing breeding program research, extension and scaling.

The anticipated capacity impacts in capture fisheries builds upon the characterization studies of MYFish and will be fully realized during the second phase of investment by ACIAR in MYFish2 (2017-2020). The expected impacts are:

- Fishery management data used in the planning and management of complex multifunctional landscapes in the AD and resulting in better and sustainable fisheries strategies and programming;
- FRDN members have the capacity to design and field test improved fisheries management practices;
- Collaboration and networking among FRDN members is strengthened through interaction on the analysis of result summaries from the testing of different fishery management practices; and
- FRDN members regularly participating in national and international meetings and resulting in opportunities for knowledge sharing and joint publications.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

The impact of the changes in monetary wellbeing resulting from the project are divided into three key areas: (1) economic impacts drawn from individual research pilots at household level; (2) economic impacts resulting from better targeted investments in SSA; and (3) impacts from scaling technologies and practices outside the project scope.

The diversification of aquaculture systems is creating new marketing and trade opportunities in Myanmar particularly in the domestic market (Belton et al, 2015). MYFish piloted seven production systems (eel, rice-fish, carp poly-culture, small-indigenous species (mola, climbing perch, gourami and cage culture). The domestic market for fish in Myanmar is large (53 million people) and expanding with urbanization and improved incomes. Project research in SSA and particularly SIS was ideally suited to the domestic market. The project provided scope to pilot the production of a variety of new species that could be farmed commercially by small-scale producers to meet the demand from middle class and low income consumers. SIS seed production was tested at three DoF hatcheries and one village-based feed production system was tested for SSA. The project has created entry points into the aquaculture value chains for many new producers and associated service providers.

The economic impact of MYFish pilots is estimated to have provided a gross income per household of Usd$300 per cycle. For the 329 households that participated in the pilot research this has provided an additional income of $Usd 98,000 to the household economy across the 12 villages involved in the pilots or $Usd 8,000 per village.

The economic potential shown by the MYFish research on SSA has attracted additional investments from the international donor community. The WorldFish and DoF collaboration on SSA has received Usd$3.3 million grant for scaling SSA to the AD and CDZ through the LIFT innovation and learning fund in 2015, and in 2017, the collaboration received an additional $Usd3.0 million funding from the EU to scale SSA to Saging Region and Shan State. Each project will scale MYFish SSA technologies to several hundred villages to target a total beneficiary population of 15,000 households over the next 5 years. By the end of 2016 over 700 households representing nearly 2,800 people were benefiting from SSA. The

estimated total gross income from SSA production technologies for 15,000 households from one-production cycle is estimated to add Usd$4.5million per year to the region's economy.

Research carried out by MSU has estimated that there are over 200,000 small-scale household ponds used primarily for storage of water throughout the Delta (Belton, 2015). Increasingly these ponds are being used for aquaculture as the transportation network and power infrastructure improves access to the markets in Yangon. The large numbers of small homestead ponds identified in the AD highlight the potential for expansion of 'backyard' aquaculture for both household food security and for the domestic market. The economic potential of operationalising SSA across the AD is estimated to be worth Usd$60 million per year.

Impacts anticipated in 5-years

The anticipated economic impacts in aquaculture are:

- New private sector investments in small-medium enterprises providing feed and seed input supplies and post-harvest processing that emerge with the growth of SSA sub-sector;
- Scaling projects improving the efficiency and sustainable development of the SSA sector through better understanding of the product to market combinations for the domestic market and processing networks that have a positive impact on sector earnings; and
- Strengthened and developed networks that support fish processing and marketing of fish products particularly in the domestic market and leading to more efficient use of fish, fishers and middlemen receiving higher prices for their products.

The project has generated knowledge and data on capture fisheries management and how they can be improved to utilize fishery resources more efficiently. These impacts will be tested and quantified during the second phase of investment by ACIAR in MYFish2 (2017-2020). The anticipated economic impact of improving capture fisheries management through MYFish2 (2017-2020) over the next 5 years are:

- Improved income and livelihood security of fishing-dependent poor households through increasing fish production;
- Sustained increase in fish production resulting in improved economic outputs of the fisheries sector throughout its value chain; and
- Better return on community and private sector investments in fisheries, resulting from improved management of the resource (e.g stocking optimised, reduction in fishing effort and costs of law enforcement).

8.3.2 Social impacts

The impact of social changes resulting from the project are divided into two key areas: (1) social impacts through participatory research used to test and adapt technologies and practices; and (2) social impacts through the promotion of appropriate technologies and practices that benefit men, women and youth.

The research approach adopted by DoF and the NGOs operating under the SSA development projects has engaged men and women in the monitoring and reporting on the outputs of the interventions. Households have been engaged in monitoring the quantity of feeds, mortality rates and production using daily record books and in monthly reporting through focus group discussions to assess fish growth and harvest. For homestead ponds, women and youth have been predominantly involved in maintaining and monitoring the ponds whilst for larger ponds this has been carried out mainly by men. The research and SSA training for the pilots and scaling projects has engaged men and women and is based upon establishing producer groups as organised bodies that share learning and data on the progress of the ponds. Groups were also able to arrange and manage credit and the trading and marketing of fish. Increasing the participation of women, men and local communities in SSA R&D has improved village level coordination and has helped to build social cohesion to assist communities become better organised around fish production and marketing.

The SSA technologies promoted by MYFish have been designed to maximise the social benefits and impacts for men, women and family. This is evidenced in the SSA household survey carried out by DoF that indicated that SSA contributes to the enhancement of household incomes (52%); increases fish consumption (21%); reduces expenditure on purchasing fish for consumption (15%); and increases the frequency of eating fish when the market prices are high (12%). The evidence from the SSA survey indicated that the technologies promoted by MYFish are able to secure fish supplies and provide greater flexibility in fresh fish access and local marketing opportunities for men, women and youth.

At household level, capacity development has focussed on the introduction of small-indigenous species (SIS) as a low cost, low technology and low tropic level species that can supplement traditional poly-carp systems. Integrating SIS with traditional poly-carp systems has encouraged households to test new fish species and to augment income, food and nutrition security.

The SSA household survey showed that 33% of the producers in the AD and 21% in the CDZ are female. Traditionally women play a major role in household consumption and distribution of fish. They purchase fish for food and select which type of fish to eat, and how it is cooked. In the MYFish pilots and scaling projects women have become an important entry point for improving household nutrition and consumption of fish. Furthermore, the testing of homestead ponds that is led mainly by women has providing the technical know-how to encourage families to invest in larger ponds that are managed by men. The homestead pond has acted as a learning platform reducing the risk to invest in larger, commercially orientated ponds.

Impacts anticipated in 5-years

The anticipated social impacts in aquaculture are:

- Better knowledge of producer and end-user preferences (men /women) improving fish production and marketing; and
- Inclusive, gender-sensitive, and environment-friendly approaches to support sustainable intensification of fish production.

The anticipated social impacts in capture fisheries builds upon the characterization studies of MYFish and will be fully realized during the second phase of investment by ACIAR in MYFish2 (2017-2020). The expected impacts are:

- Increased participation of local communities in the co-management of fisheries and natural resources, in decision-making processes, and recognition of the role of fisheries as social safeguards for the landless poor; and
- Secured property rights for small-scale fishers through the extension of tender and leasehold fishing arrangements to communities, providing greater benefits, inclusion and equity.

8.3.3 Environmental impacts

The impact of environmental changes to Myanmar's natural resources and their management resulting from the project are divided into two key areas: (1) managing biosecurity risks and impacts; and (2) managing changes in fisheries use and access.

Currently there are no observable environmental impacts associated with the aquaculture R&D promoted by the project. This includes the approximately 350 households engaged in the pilot research projects and also by the on-station trials at DoF hatcheries. The research approach has been in line with promoting indigenous fish for aquaculture in the AD and CDZ. This approach has been adopted by the SSA development projects funded by LIFT and the EU that are scaling MYFish technologies to over 15,000 households over the next five years.

The project has made a contribution to the preparation of DoF for the introduction of GIFT tilapia in Myanmar. The focus has been on mitigating and managing environmental risks by building the technical capacity of DoF staff and hatchery managers to receive and manage tilapia brood stock. In 2016 following an agreement with DoF, GIFT tilapia fry was imported

from Malaysia into Myanmar to establish a breeding nucleus for nurturing and future distribution. Tilapia has been present in Myanmar for more than seven decades and the decision to import the GIFT strain is in accordance with the Aquaculture Stewardship Council Standard (ASC) for tilapia farming that tilapia should not be introduced into new areas. However, environmental risks do need to be managed and mitigated particularly when working with government that has limited hatchery capacity. The main risks associated with introducing GIFT are biosecurity and minimising the risk of losing fish into nature through flooding or escapees and to minimise disease risks by maintaining hygiene standards.

A management strategy for GIFT in Myanmar has been developed to adhere to the ASC standard that states that tilapia culture should only be done using mono sex fingerling to minimize the risk of breeding in nature. The approach adopted in Myanmar is to establish sex reversed (SR) tilapia, which is in compliance with the standard. In addition, the breeding nucleus must have the highest practical biosecurity and hygiene measures in place and should be closed for introduction of further genetic material. The approach adopted is to build the technical capacities in DoF and also private hatcheries so that the management systems and infrastructure are in place to maintain and ultimately to supply high quality mono-sex GIFT tilapia in support of SSA development.

Conversely there are no observable environmental impacts associated with the capture fisheries R&D promoted by the project. However, capture fisheries research has focussed on preparing interventions that will adapt and change existing fishery management practices and these will be tested during the second phase of ACIAR funding under MYFish2 (2017-2020).

MYFish2 will seek to improve existing management practices through co-management and by greater participation and access of fishing communities to fishery resources. The testing of different management arrangements will combine the utilisation of fishery resources with improved management that is participatory and based on scientific and local knowledge. MYFish2 will ensure that interventions promoted are sustainable and where possible have a positive impact on the environment. The project will facilitate dialogue, strengthen the capacity for adaptive management and designate important fish breeding areas for fish stock and biodiversity protection.

Support for stock enhancement activities of the inland leasehold fisheries will use indigenous fish species rather than exotics, wherever appropriate and build upon the research work on several indigenous species that have already been tested and piloted by MYFish for SSA development and extend this to leasehold and open access waterbodies. Where current stock enhancement practices are already using exotic species as a result of their availability from government and private hatcheries, expertise will be used to rationalise their use, (particularly in closed water bodies where the recruitment of indigenous species is limited), to enhance the production benefits for small-scale fishers. Applying a pragmatic approach to the management of closed water bodies over the use of exotic species will be used to boost production but limit their environmental impacts on wider ecosystems.

Impacts anticipated in 5-years

The anticipated environmental impacts in aquaculture are:

- Compliance with Aquaculture Stewardship Council Standard (ASC) to manage and mitigate biosecurity and hygiene risks for introducing faster growing and resilient strains of tilapia with improved access to quality seeds for their production;

The anticipated environmental impacts in capture fisheries are:

- The implementation of and compliance with agreed management plans and community rules to manage use and access to fishery resources; and
- Improved co-management of fishery areas and the protection of ecosystem services to maintain fish yields and bio-diversity.

8.4 Communication and dissemination activities

The impact of the communications resulting from the project are divided into three key areas: (1) media outputs, national publications and digital library used to enhance information exchange and learning; (2) science forums and seminars used to promote research and policy dialogue between government and fishery sector; and (3) science networks and international collaborations used to share and develop new knowledge and research findings.

The communications with DoF and the Ministry have been excellent. The project has conducted workshops and symposia, disseminated research findings through national publications and newsletters and produced policy briefs and other reports. National media coverage has included newspaper articles and TV stories on the project that has promoted the project and its findings. There has also been high profile media exposure on the work of the project via the BBC and CNN in 2016 (http://www.bbc.com/news/business-36030442). The stories run by the BBC and CNN were linked to post national election interest in Myanmar in 2016 and in homestead aquaculture.

Fishery Information Centre (FIC) (2016) – is a digital database of research papers, project reports, informative posters and training books relating to Myanmar fisheries. The server is accessible on a website (ww.dof-myanmar-fic.org) and enables national and international researchers to exchange resources and knowledge on the sector. The FIC partnered with FAO to provide its users with access to their international fisheries and agriculture repository (www.fao.org/agora/en/). Such access to FIC users is provided through dedicated library desktops in DoF, which are acting as a node between Universities and FAO to facilitate access throughout the country.

National publications (2016) – the FRDN and DoF research reports have been issued with a publication number provided by the Ministry of Information to DoF so that the reports can be referenced and accessed online. The unique publication series enables national researchers to publish their research through the national libraries initiative, which is assessable internationally through DoF's digital library, the Fishery Information Centre (FIC).

National Symposium (2013-2016) - A total of four national symposia were convened by the project in Yangon, Mandalay and twice in NayPyiTaw in March 2013, December 2013, December 2014 and December 2016. The format of the symposia was to present research papers that had been funded through the FRDN and also research carried out by the Activity Working Groups (AWG). In total over 250 participants including the Minister and Deputy Minister attended the symposia and provided an opportunity for cross-sector discussions and exchange of knowledge between institutions based on the research outputs. Several collaborative research projects have resulted from the symposia.

Project Newsletter (2013-2015) - Three editions of MYFish newsletter were produced detailing the research and pilot activities. The Newsletter included a regular message from the DG of DoF and 1,000 copies produced for each edition and distributed to all DoF offices in the AD and CDZ. The newsletter was produced in English and Burmese.

Collaborations with other projects, programs and international organisations – the MYFish approach to research and capacity building received strong support from DoF and the Minister. The project has been successful in nurturing international research collaborations specifically targeted toward building links with DoF and FRDN members. The following is a summary of the collaborations and science networks developed by the project.

WorldFish Country Office (2015): the success of MYFish led to a WorldFish commitment to develop a country program office and for Myanmar to become a focal country for the FISH CGIAR Research Program (CRP). A 10-year country agreement was ratified by the Minister of Fishery, Livestock and Rural Development in December 2015 and incorporated into the agreement the R&D approach developed by MYFish to build sector capacity building of DoF and FRDN.

ACIAR MYFARM collaboration and rice-fish development projects (2011-2017): MYFish developed SSA pilots including the testing of integrated rice-fish culture systems and worked with IRRI through the MYRice project to identify sites where pilots on rice and fish could be carried out. This led to an ACIAR small-research grant in 2016 to formalise the rice-fish research between MYFish and MYRice projects and this facilitated inter-departmental collaborations between DoF and the Departments of Agriculture and Agriculture Research (DOA and DAR). In 2017, a large research project proposal was developed by WorldFihs and IRRI for ACIAR funding based on the findings of the MYFish pilots and small-research grant project. The AUD$2.6 million four-year project called 'Development of Rice Fish Systems (RFS) in the Ayeyarwady Delta, Myanmar' (FIS/2016/135) will start in 2017 and aims to improve productivity and profitability of rice-fish systems with a focus on favourable agro-ecological zones in the AD.

Stockholm Resilience Center (SRC) (2013-2016): Dr Max Troell from SRC has supported MYFish by the placement of an intern in 2013 to research mud crab, in 2014 participated in the national symposium providing an assessment of the presentations and papers, and in 2016 by participating in policy brief writeshop.

Solidaridad and Wageningen University (WUR) (2015): in collaboration with DoF and MFF, Solidaradad and WUR undertook a joint study with WorldFish to assess the potential linkages between large and small aquaculture producers in the AD. This study was identified in the AD scoping.

Voluntary Services Overseas (VSO) (2015): an agreement between WorldFish and VSO paved the way to place a volunteer in the CDZ to support SSA development. An aquaculture technologist from the Philippines, joined MYFish in October 2014 and supported the FRDN, preparation of national symposium and preparing the SSA pilot program in Sagaing CDZ. DoF was highly supportive of the initiative and collaborated to provide accommodation and counterpart.

European Commission (EC) (2015): together with Solidaradad and WUR, WorldFish and DoF prepared a concept note for a sustainable aquaculture program. The concept note was approved by the EC and has become a six-year Euro 25 million aquaculture program called MYSAP (Myanmar Sustainable Aquaculture Program).

Danish Embassy (DANIDA) (2014): WorldFish and DoF provided guidance to the Danish Embassy and DANIDA to undertake a scoping to develop a project investment in fisheries in Myanmar. The scoping involved facilitating a workshop in NayPyiTaw with the Union Minister, Deputy Minister, Danish Ambassador and the regional fishery officers of Rakhine, Ayeyarwady, and Mon states. A Euro 25 million investment has been approved by the Danish Government for a coastal co-management project as recommended by WorldFish and DoF.

LIFT's innovation and learning fund (2014): a concept note on SSA development in the AD and CDZ was submitted to LIFT and successfully funded a US$3.3 million small-scale aquaculture development project (2015-18). The project called MYCulture involves the FRDN, DoF and builds directly from the learning and innovations from MYFish. MYCulture is scaling SSA technologies to 10,000 households.

FAO / BOBLME (2014): this represented the first funded collaboration with MYFish and provided 12-months of funding through the BOBLME[6] Program to co-fund research. The funds supported AWG research and two FRDN studies: 1) the Hilsa (*Tenualosa ilisha*) migration study along the Ayeyarwady River from the AD to the CDZ coordinated by DoF's AWG on capture fisheries; and 2) two mini-research projects on the value chain of Hilsa facilitated and livelihoods of Hilsa fishers to develop capacity.

*CGIAR Research Projects – AAS, GRiSP and WLE (*2014): researchers from IRRI, WorldFish and IWMI, as well as national partners, participated in a scoping mission to the

[6] *Bay of Bengal Large Marine Ecosystem*

AD. The purpose was to identify opportunities for the CGIAR Research Programs (CRPs) to collaborate in Myanmar on joint research and development. The scoping mission built upon the current partnership with government and in particular the ACIAR projects.

Save the Children (2014): collaboration with Save the Children centred on fish and human nutrition and in deepening the understanding and awareness of the contribution of fish to family food and nutrition security; a fish nutrition brief on SIS was produced in English and Burmese.

Economy and Environment Program for Southeast Asia (EEPSEA) (2014): funded by the Swedish International Development Cooperation Agency (Sida) and the Canadian International Development Agency (CIDA) and managed by WorldFish. The program supports training and research in environmental and resource economics and trained three researchers from Dagon University in value chain assessment.

9 Conclusions and recommendations

9.1 Conclusions

The project “Improving research and development of Myanmar’s inland and coastal Fisheries” (MYFish) aimed to strengthen research and development capacity in Myanmar’s capture and culture fisheries to facilitate co-management and to develop small-scale aquaculture (SSA) in the Ayeyarwady Delta (AD) and Central Dry Zone (CDZ). MYFish has been a timely project for the Department of Fisheries (DoF) coinciding with the political and rural reforms of the rural sector initiated in 2011 by the new civilian government. The project has promoted new understandings of the fishery sector and DoF are increasingly applying research for development and management that is stimulating new policy directions in rural aquaculture and fisheries management.

MYFish has made considerable progress in achieving its objectives. It has demonstrated increases in production by 40% and doubling of gross income through SSA and producer networks, and has improved research, development and extension capabilities that have resulted in new knowledge and learning. The project has benefited from the close partnership developed between WorldFish and the Department of Fisheries (DoF) and embedding the project within the institution of DoF. The partnership has successfully engaged technical staff, researchers and policy makers from DoF in the research process and has extended these interactions across the sector to actively engage NGOs, universities, private sector, fishers and producers in research, development and extension activities.

MYFish applied a highly participatory approach to research, development and extension (R,D&E). It is the first intervention in fisheries to allocate funds directly to DoF and this has strengthened the institutional capacity of DoF to carry-out research projects. The project developed two successful research modalities that have facilitated and strengthened research capabilities within DoF and across the sector. The first modality is the Activity Working Groups (AWGs) that are research groups set-up within DoF and led by staff with technical experience in aquaculture and capture fisheries. The second modality is called the Fisheries Research and Development and Network (FRDN) and is an informal science network that has brought together DoF with other sector partners including national universities, private sector and NGOs to share knowledge and to identify and implement fisheries research.

The AWGs and the FRDN have provided opportunities for promoting institutional and behavioural change by broadening the research focus and making fisheries more relevant to development. MYFish has piloted small-scale aquaculture (SSA) in the AD and CDZ with research methodologies that use a combination of on-station trials and participatory ‘farmer-field school’ approaches. These methodologies provide DoF with the skills to design, test, monitor, and review the performances of SSA pilots and have incorporated ‘real-world’ settings with controlled on-station research. MYFish has introduced and developed a gender strategy that has mainstreamed gender in the research process, M&E and organisations. The project has impacted on DoF’s discourse on research and has shifted the perspective of fisheries from one centred on productivity and revenue rising to include social and cultural elements to benefit fishing communities and rural households. Due to the complexity of capture fisheries, the testing of co-management practices has been limited to carrying out further analysis on the governance and management systems to identify potential new approaches for future pilots. A key output of the analysis has been the development of a second phase of MYFish (*Improving fishery management in support of better governance of Myanmar’s inland and delta fisheries (MYFish 2)* FIS/2015/046 that starts in January 1st 2017

The FRDN has helped place DoF at the centre of the learning process in Myanmar fisheries and encouraged research collaborations with universities, private sector and NGOs. The FRDN has funded over 20 research projects and promoted interactions between members through the hosting of annual symposia. DoF has established a publishing portfolio that is

linked to an online digital library called the Fishery Information Centre (FIC) (dof.myanmar.fic@gmail.com). Launched in December 2016, the FIC is cataloguing fishery science in Myanmar and publishing FRDN studies and DoF reports. The FIC has become the largest repository of Myanmar specific information on fisheries and is providing access to previously unseen data including PhD theses, books and reports.

The demand from the Ministry and DoF for continued interaction with MYFish has created the basis for a long-term program of support for fisheries research. WorldFish has invested in developing a country program office and a 10-year agreement has been signed with the Ministry in 2015. This has formalized many of the modalities developed under MYFish. Policy support is maintained through regular communications and meetings with DoF and Ministry. This has helped to facilitate access to DoF hatcheries for research on indigenous species and to hold technical and policy discussions including policy advisories for the new National League of Democracy (NLD) Government.

The scaling of proven technologies and techniques have been an important development goal for the project which WorldFish and DoF have pursued through the levering of additional funding from donors and development agencies. In 2015, Usd$3.3 million was awarded by the Livelihood and Food Security Trust (LIFT) for a four-year project to scale MYFish SSA technologies and techniques to farmers in the AD and CDZ. The project called MYCulture is scaling SSA to over 10,000 rural households to benefit more than 40,000 people. By the end of 2016, MYCulture had successfully engaged 700 households and approximately 2,800 people in SSA, was supporting five DoF hatcheries to diversify and supply small-indigenous fish species to producers, and had extended village feed supply technologies to 20 villages. In 2017, a second SSA development project was awarded to WorldFish and DoF by the European Union (EU). Valued at USd$3.0 million, MYSAP-IN is scaling MYFish SSA technologies and techniques to a further 5,000 households in the upland areas of Shan State and Sagaing Region. The estimated economic return from SSA production technologies that have been developed by MYFish and will be scaled out by the LIFT and EU projects to 15,000 households are estimated to be worth Usd$4.5million by 2019. This more than doubles on a yearly basis the return made by the Australian Government to the four-year MYFish project.

The new National League of Democracy Government brings new opportunities and challenges to the fishery sector. The science networks and partnerships developed by MYFish will increasingly play an important role in building trust and stimulating change particularly as the number of investors in fisheries grow and demand on the sector increase. Fisheries R&D will need to be dynamic to deliver and inform policies. The continued support of projects like MYFish that strengthen national fisheries R&D capacities will be important to institutions like DoF to support the identification of research priorities and implement projects to meet national development needs.

9.2 Recommendations

A number of factors have contributed to achieving the R&D impacts that have been facilitated by MYFish. These include but are not limited to the ability of the project to partner and fund DoF directly, embedding the project within DoF and engaging senior staff and policy makers in the design and implementation of the project. The following recommendations can guide future project design and interventions that aim to strengthen national institutional capacity and skills in R,D&E and are based on the lessons learned from implementing MYFish.

1. Strengthen the awareness and understanding of research in development: promote and build research in the design and implementation of development interventions to enhance learning, generate new knowledge, measure impacts and attract donor support;
2. Embed R&D projects within national institutions: design projects to locate implementing organisations such as WorldFish within the institutional framework of national research and management bodies like DoF to stimulate interactions, trust and capacity building exchanges between national staff and specialists;

3. Employ participatory research methodologies: enhance development impacts and research opportunities by engaging the people being researched (farmers, producers, women and youth) in the research process to encourage innovation, economic and policy development;
4. Stimulate partner-led research: use small-grant research funding and associated R&D capacity building interventions to strengthen national research capacities to engage government, NGO, university and private sector partners in the research process;
5. Develop sustainable and enduring information systems: engage national research institutions in digitising and storage of historical and national research data including developing national publication capacities to engage national researchers in publication and to ensure information is accessible for future research;
6. Build partnerships and science networks: use partnership to build ownership, representation and engagement of national institutions and organisations in the research process that can be enhanced through international science collaborations;
7. Engage and interact with higher managerial/policy levels: build relations and regular communications with senior managers and policy makers to secure and build awareness, and support policy uptake of project outputs and outcomes;
8. Communicate policy outcomes during project implementation: look for and communicate policy outcomes at the earliest possible time and throughout the project by developing policy briefs rather than wait until all the research is completed;
9. Plan long-term development strategies: long-term development should be articulated and enabled through a series of immediate and tangible outputs and outcomes that combine to facilitate longer-term development needs; and
10. Make long-term institutional commitment: use R&D projects to develop programs of science and research that can support and justify long-term institutional commitments by national and international research bodies and partners.

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11 Appendixes

11.1 Appendix 1: Summary of Researchable Projects identified during diagnostic and scoping in Ayeyarwady Delta and Central Dry Zone

11.1.1 Ayeyarwady Delta

Component	Objective	Research Project
Fisheries and supporting ecosystems	*Capture fisheries, re-stocking and agro-ecological zonation* • Develop a more precise definition of the agro-ecological zones of the AD • Research in biology to focus on medium to long-term trends in species composition, catches and dominance • Better understand the relationship between AE zones and livelihood options, vulnerability and poverty • improve fish stocking by looking at its locations, density, timing, outcomes, and impact on local biodiversity • better understand the threats and opportunities of rice farming extension for fish resources • to assess the role and efficiency of fish refuges as part of resource protection and production enhancement measures	- assess the extent and duration of the salinity concentration in the coastal and estuarine zones - develop / collate recent GIS layers of land use and vegetation cover in AD to assess land aquatic resource use and access - assess the impact of re-stocking on the different AE zones – study to look at the location, density, timing, outcomes, and impact on local biodiversity. - Work with Universities to support taxonomic studies and identification of Myanmar inland fish species.
	Commercial fisheries and production statistics • Better understand and identify the location of commercial fish and in particular the breeding and feeding grounds of Hilsa throughout the Delta • A critical assessment and analysis of existing reliable data on production and capture fisheries	- Assessment of upstream migrations and identification of Hilsa breeding grounds - fishermen's interviews along the main rivers and include Hilsa and other target species to be defined. - compilation and analysis of catch data from lease, tendered and open access sites to be monitored and representative of the zones - study would be done in 3 sites in 3 zones, focusing on data entry and analysis of catch composition over 5-10 years. The analysis would focus on changes in fish abundance, species composition, and relative dominance, and include other indicators - fish price monitoring
	Sustainable fishery productions systems and external drivers of change - Sedimentation and production - explore the relationships between river sediment retention by dams, outflow of sediments/nutrients in the coastal zone and role of river nutrients in the productivity of the coastal zone	- the potential productivity of the delta, based on coastline, discharge, depth, nutrient concentration or degree of exploitation; cf. D. Pauly's global study, a study about can be conducted
Component	**Objective**	**Research Project**
Aquaculture	*Small-scale household aquaculture* • Identify most suitable technologies, and conditions required for their successful adoption. • Identify policy, institutional and investments needed to scale out	• Analysis of outcomes from existing small-scale aquaculture interventions, and identify suitable technologies. • Conduct a policy, institutional and investment analysis to develop strategies for scaling out promising technical innovations.

	promising small-scale aquaculture innovations. • Support emergence of small-scale aquaculture in suitable agro-ecological regions that contribute income and nutrition to poor and vulnerable producing households • Develop land use and other policies that support productive agricultural-aquatic landscapes. -	• GIS/mapping exercise to identify suitable agro-ecologies within the delta, and clusters where small-scale aquaculture might best be initiated. • Study of rice-fish farming. • Conduct pilots in selected clusters • Investigate integrated livestock/vegetable/fish systems for improved household nutrition and income. • Opportunities for integration of small indigenous fish species (SIS) to improve pond productivity and nutrition among children and women, using experiences from USAID and IFAD programs in Bangladesh.
	Commercial (SME) aquaculture • Requirements for improvement of fish production systems identified based on technical, economic and market analysis of present systems. • Based on these analyses, prepare investment strategies to develop competitive small and medium –scale commercial aquaculture enterprises that generate employment and income. • Conduct research on social (employment) performance of existing commercial aquaculture enterprises to identify strategies to improve social and employment impacts from commercial aquaculture. • Explore interactions between commercial sector, and small-scale household aquaculture and opportunities for mutual benefit (eg, contract farming, feed credit arrangements etc). • Develop a fish hatchery improvement program that is based on sound genetic management of Myanmar's carp resources.	• Conduct analysis of existing commercial enterprises, economic performance and identify opportunities for improvement of existing technologies/farming systems. • Investment requirements for growth of SME aquaculture • Social impact assessment of small to large-scale commercial aquaculture enterprises • Study of aquaculture species diversification (including opportunities for improved tilapia strain introduction/impact) • Market studies of farmed freshwater fish for domestic and export markets. • Fish hatchery and genetic improvement of major carps (possible cooperation with Bangladesh/South Asia).
Component	**Objective**	**Research Project**
Value Chains	• To understand the functioning, efficiency and performance of the fish and fish product value chains in AD to identify opportunities for upgrading the chains to improve their performance with benefits being distributed equitably along the chain and becoming pro-poor and pro-women.	• Rapid VC broad brush analysis of fish and fish product value chains in the AD to identify chains in which poor play a significant role. • Focus on 2-3 chains in which poor households are significantly involved in different segments (production, processing, marketing) and undertake a detailed gendered Value chain analysis to identify opportunities for improved performance and involvement of poor and women in a more beneficial manner to contribute to their income security and stability; increased productivity; reduced vulnerability and risk. • Testing some identified technical and institutional innovations to improve performance of value chains and make them pro-poor, combined with robust monitoring and learning to draw lessons and communicate them to support scaling up and out.

Component	Objective	Research Project
Poverty, Vulnerability and Gender Equity 1.	*Livelihoods and poverty* • Improving the range and quality of livelihood choices for poorer households (particularly those without access to land or a boat) so they could benefit more from fisheries and aquatic-agricultural systems (AAS). • Improving the asset accumulation capability of poorer households to become more resilient and be able to cope with disasters and change.	• Mapping of livelihood strategies and assets of men and women in poor households in AD to understand the current situation, constraints and opportunities • Testing options for diversifying livelihoods and increasing the assets of men and women in the poor households
	Nutrition • Improving the contribution of fisheries and fish products to food & nutrition security in different areas of the Delta and beyond.	• A panel study on intra-household consumption and nutrition patterns
	Gender equity • Enhancing the productivity and diversity of livelihoods of poor women and adolescent girls in the fishery sector, in order to improve household nutrition, resilience and their well-being in a sustainable manner.	• A gender situational analysis to understand the social norms underlying the gender issues in AD and their influence on livelihood options and choices of women and girls. • Livelihood, value chain and other studies being proposed during the characterization should all be strongly gendered. • Testing various innovations and interventions which can improve poor women's access to technology, knowledge and services so they can improve their livelihood options and choices. This should be couple with efforts to enhance their voice and participation in decision-making at a community level.
Component	**Objective**	**Research Project**
Institutions and Governance	*Policy reforms and fishery management* • Ensure that the Regional Government and DoF Office in Pathein has the capacity and know-how to monitor and evaluate the impact of the decentralization & reform policies on fishery management • Develop a fishery management plan for the Delta that engages DoF at the central and regional levels and applies an eco-system approach that engages different stakeholders in the FM process • Develop a partnership approach to fishery management in the Delta to test different fishery management approaches in the leasable, open & reserve fishery areas; • Understand the various stakeholders and institutional relationships of those individuals and groups that are engaged in the sector	• Work with DoF Office in Pathein to develop a set of research tools and methods to assess the impact of policy and legal reforms on fishery management capacity • Make a participatory assessment of the decentralization and reform policies on the current system of fishery management and governance systems • Work with central and Regional DoF to undertake a stakeholder and institutional analysis of fishers, traders and collectors in a sample of leasable, open & reserve fishery areas • Develop a communication plan for reporting research results with all stakeholders through various media outlets such as newsletter • Work with the all stakeholders to develop a set of locally specific agreed rules and guidelines for the use and access to leasable, open & reserve fishery areas • Work with DoF Office in Pathein to develop an MCS system for fishery management that can be applied in the leasable, open & reserve fishery areas
	Resource access &Governance system • Develop a conflict resolution process by bringing together and articulating the conflict issues between the various	• Work with the Regional Government and DoF Office in Pathein to facilitate a series of contact meetings between different users of a sample of leasable fisheries to better understand the conflicts and to develop a set of rules and guidelines to test

	stakeholders in an open forum • Develop a map of the natural and social resources of the leasehold fishery of the delta highlighting conflict areas and issues • Understand the importance of the leasehold system to people in terms of spatial and seasonal impacts	improved equity of use and benefit • Pilot single new transparent auction system to replace closed lease and tender systems. • Work with the Regional Government and DoF Office in Pathein to develop a set of research tools and methods to map out and assess the conflicts issues around the leasehold fishery • Make a participatory assessment of the distribution of benefits (spatial and temporal) for different stakeholders that use and access leasehold fisheries
Component	**Objective**	**Research Project**
Knowledge Management	• Assess the current knowledge management systems within the Delta and how data on the fishery and its users is collected and applied by DoF • Assess the production figures from the Delta based on the best available data and expert opinion to agree on the most likely status of the fishery resources • Strengthen the quality of routine data collection by DoF including socio-economic and market data so that it contributes to fishery resource planning and management in the Delta • Establish an integrated knowledge management system that broadens engagement of key stakeholders in the collection and dissemination of data	• Work with central and regional DoF as well as supporting stakeholders to assess and map out the current knowledge management systems within the Delta and how this can be improved • Convene an experts workshop on fishery production and stocks and make an evaluation of fish production in the Delta using the best available data • Work with central and regional DoF to test various data collection systems on fish production in both the inland and marine fisheries including socio-economic and marketing data.
Component	**Objective**	**Research Project**
Extension	• Acquire necessary data to equip relevant agencies with information needed to engage in extension planning. • Develop a strategic plan for establishing integrated fisheries extension services in the AD. • Develop and evaluate adapted extension pathways with potential extension service providers as well as concerned households. • Identify institutional constraints and capacity needs among extension service providers. • Introduce a policy dialogue process that supports building up the fisheries extension services.	• Exploring rice-fish as a livelihood option could be an item for collaboration between the Rice, Fish, and Livelihood components. The collaboration would need to include technical aspects (adaptation of farming systems, appropriate species) as well as extension (training for DoF/DoA staff; cooperation across Ministries) and livelihoods (input/output economics, risks, acceptability) • Map out social networks between fishermen – collectors – traders – wholesalers. This includes understanding value chains, main decision factors as well as traditional client-patron relations (social responsibility) to understand where risks lies and who is shouldering them. • Examine the extension approaches currently used at the Fisheries Institute and develop a comprehensive extension strategy for small-scale fisheries and aquaculture by using an action research framework. • Baseline surveys as planned in C5 to be conducted in conjunction with DoF, MFF as well as DoA. • Identify current forms of extension, including private extension, traditional skills development, and diverse forms of information gathering is critical if extension concepts are to be adapted and accepted.

11.1.2 Central Dry Zone

Theme	Researchable Project	Details
Fisheries and supporting ecosystems	1. Assessment of the relative role of fish in the livelihood of selected villages of the CDZ:	• GIS-based analysis of the extent of river, floodplain and rice field habitats in the CDZ; • GIS-based analysis of the population living in or near (1/5/10 km distance) these habitats; • Selection of 5 to 10 villages in coordination with the other components of the MYFish project, and random selection of 10 households in each village; • Use of the methodology based on welfare questionnaires and digital tablets already implemented in the ACIAR-funded project "Assessing economic and welfare values of fish in the Lower Mekong Basin" in Cambodia; • Assessment of the relative role of fish in wealth, nutrition, labor, health and resilience of households surveyed (Figure 8). This activity can be coupled with a monitoring of possible development interventions by other MYFish components
	2. Identification of the migration patterns and breeding sites known for target freshwater species of commercial interest (including Hilsa):	• Adaptation of the methodology developed for such studies by Poulsen et al. 2000 and Baran et al. 2011 ; • Selection of 10 to 15 relevant survey sites along the Ayeyarwady River, from the upper part of the delta to the upper part of the CDZ; • Field survey and data analysis
	3. Identification of the stocking practices providing the best outcome for a given effort:	• Literature review about most effective and recommended stocking practices in Asia; • Production of terms of reference for an extensive research study on stocking (next phase of the project).
Production systems and livelihoods	4. Understanding the performance of existing aquaculture systems in diverse agro-ecological contexts of CDZ:	• To assess the performance of existing aquaculture systems against the key systems properties, namely productivity, stability, equitability and sustainability, including nutrition; and • To identify opportunities for and constraints to aquaculture development in agro-ecological, social, economic and institutional perspectives.
	5. Characterization of CDZ based on its agro-ecological and social and economic potential for aquaculture development:	• To identify agro-ecological and socio economic determinants to aquaculture development across the CDZ; and • To analyse biophysical properties, socio-economic and institutional circumstances and supporting infrastructures and services.
	6. Identification of aquaculture options feasible for different agro-ecological and socio-economic environments:	• To identify potential interventions for improving the performance of aquaculture systems in irrigated and rainfed agro-ecologies; and • To analyse potential for improving livelihoods (food, nutrition, income) of resource-poor farming families through aquaculture interventions.
	7. Demonstration of the benefits of aquaculture in diversification of livelihoods in CDZ:	• To pilot farmer-managed on-farm trials on potential aquaculture options for irrigated and rainfed agro-ecologies; • To devise recommendations for wider dissemination of promising aquaculture options tested and validated through on-farm trials; and • To explore improved strains, such as Nile tilapia as a short production cycle species
Market and value chains	8. Document institutional/informal market arrangements and assess benefits and detriments for small-scale stakeholders:	• To identify/document good examples of benefit-sharing models and promote fair approaches to policy makers; • Explore opportunities and pilot small-scale fish producers' horizontal organization (e.g. cooperatives) to reach better markets.
	9. Assess the socio-economic impacts of medium-large scale fish	• Understanding the economics of medium to large scale processing activities and the socio-economic impacts for

	processing enterprises as well as identify benefit-sharing models and the scope for a better contribution to poverty alleviation and food security.	small scale stakeholders (e.g. employment, nutrition) and women; • Develop and pilot a small-scale value addition activity accessible for small-scale stakeholders.
	10. Understand the fish supply-demand dynamics within the CDZ and its impact on the resources exploitation and fish imports	• Assess/map the fish demand-supply dynamics of the CDZ; • Study the effects of fish demand supply dynamics on the patterns of exploitation/imports.
Governance and Institutions	11. Assessment of National and Regional Government policies and legislation and how it impacts on fisheries development	• Understand how the current policy environment and legal framework (economic, social, environmental) is applied to fisheries development; • Assess how the policy framework supports poverty alleviation and what the contribution of fisheries can be particularly for men and women; • Evaluate the opportunities for the development of mixed farming system that incorporate fisheries.
	12. Document different fishery management practices of the various leasehold and tender lot as case studies and lessons learned	• Assess cases of good cooperation between different sector agencies (i.e. fisheries, agriculture, irrigation) and evaluate their contribution to poverty alleviation; • Understand the various fishery leasehold and tender-lot systems applied in the CDZ to draw out lessons learned and best practices under the current policy framework; • Assess the different fishery management approaches including open access fisheries and evaluate their contribution to small-scale producers to address food production (rice & fish) and poverty alleviation.
	13. Develop methods for DoF to assess the needs of cluster groups in support of fishery and poverty alleviation activities	• Better understand how various approaches to poverty alleviation including cluster groups have been applied across a number of the production sectors; • Develop practical research based approaches for the assessment of the cluster groups and how they can be applied to improve fisheries development; • Test different interventions through fishery-based cluster groups for increasing incomes of small-scale farmers through better production technologies and techniques.

11.2 Appendix 2: Fishery Research and Development Network (FRDN) research protocol, proposal call and application

Protocol for the funding of mini-research projects through the Fishery Research and Development Network (FRDN)

Background

In July 2012, the Australian Center for International Agricultural Research (ACIAR) agreed to fund a four-year project focusing on building research and development capacity in the fishery sector. The project is implemented by the WorldFish Center, in collaboration with the Research & Development Division of the Department of Fisheries (DoF) under the Ministry of Livestock and Fisheries.

The aim of the project is to improve the capacity for management of Myanmar's inland capture and culture fisheries and facilitate the emergence of co management of fisheries and small-scale aquaculture as cornerstones of rural food security and livelihoods.

Three objectives have been identified:

1. To characterise the fisheries sector in the Ayeyarwady Delta and to assess the scope for fisheries development in the Central Dry Zone
2. To identify, test and then demonstrate new approaches to increase productivity, efficiency, sustainability and equity in fisheries production systems in the Ayeyarwady Delta and the Central Dry Zone.
3. To strengthen the capacity of Government, private sector and non-government organizations to carry out appropriate research & development for the fisheries sector.

FRDN

An important component of the project is to strength Research & Development (R&D) capacity within the sector including partner organizations from NGO, private sector and research institutes. To achieve this, the project will assist in the setting-up of the Fishery Research and Development Network (FRDN) that is a network of government departments, NGOs, businesses and research institutes that are engaged in fisheries research and development projects.

Members of the FRDN

- The member organizations of the Fishery Research and Development Network (FRDN) are listed below
  1. WorldFish
  2. The Department of Fisheries (DoF) of the Ministry of Livestock and Fisheries
  3. Myanmar Fishery Federation (MFF)
  4. Yangon University (YU)
  5. Foods Security Working Group

FRDN Steering Committee Meetings

- The FRDN has a steering committee that works together to oversee the appropriate use and disbursement of mini-research funds in support of the ACIAR Project objectives.
- The FRDN steering committee will meet once every 2-months
- The chair of the meeting will be WorldFish and this can be shared by other member organizations' of the FRDN as agreed by the committee
- The FRDN meetings will be hosted by the FSWG
- The Grant Officer will prepare the agenda and minutes with support from the members

FRDN Research fund

1. The FRDN research fund will be used to fund research that supports the objectives of the ACIAR project.
2. The size of each grant range between US$4,000 – 15,000, and up to 10 grants each year.
3. The research funds will be managed by a steering committee of the FRDN that will consist of representatives from the Department of Fisheries (DoF), Myanmar Fishery Federation (MFF), FSWG, research institutes and WorldFish.
4. The administration of the research fund will be made through payments authorized by the steering committee of the FRDN
5. An administer grant officer will be employed by WorldFish to oversee the research funds and they will be responsible for:
    a) setting up the administrative system of the funds with guidance from WorldFish;
    b) preparing grant agreements with those organizations that are responsible for the research proposals that are approved by the FRDN steering committee;
    c) disburse research funds to organisations using a payment schedules and rules outlined in each grant agreement, and upon receiving approval from the FRDN steering committee;
    d) compile financial reports and statements of expenditures of the research grants that are prepared and submitted by the grantee's organisations;
    e) prepare and submit a 6-monthly financial report, with accounting standards acceptable to WorldFish, and to enable WorldFish to prepare reports in the format of the donor (ACIAR) and to enable ACIAR- or WorldFish - appointed agent to conduct audits, if required.

Aim of the Protocol

- Act as guidelines by which the FRDN steering committee will oversee the management of mini-research funds that support the ACIAR Project Objectives
- The protocol can be up-dated and amended by agreement of the FRDN steering committee as and when required

Funding Process

- The funding process will be follow the steps in this following diagram

Priority setting

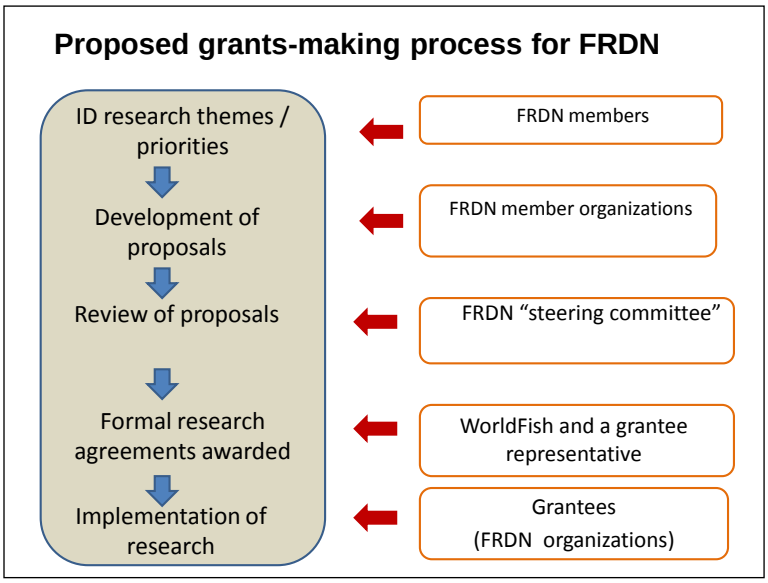
- Funding priorities for research and development projects should support the ACIAR project objectives
- Funding priorities for research and development projects will be agreed by the FRDN steering committee based on technical advice and research evidence provided by WorldFish

Budget

- The total value of the research grants for the 4-year program is AUD$183,095 or US$ 192, 690[7].

Item	FY 2012/2013 USD$	FY 2013/2014 USD$	FY 2014/2105 USD$	FY 2015/2016 USD$	Total (USD$)
Research grants	28,980	68,128	68,128	27,454	192,691

[7] US $1 = 0.9502 AUD (Exchange rate August 2012)
** Australian government fiscal year starts on 1st July and ends on 30 June*



Eligibility

Eligibility restricted to the members of FRDN

Call for proposals

- FRDN would make a call for proposals to their individual members
- After each call to proposal, WorldFish will run a seminar on the research priorities and completing the application form

Application form

- A simple 2-3 page proposal form should be completed for each research project that is short-listed by the member organization of the FRDN (see appendix)

Selection of research projects

- Pre- screening of the research projects will be carried out by each member organization of the FRDN to develop a short-list
- A short-list of projects that have been developed into proposals will be presented by the member organization to the FRDN steering committee
- The FRDN committee will select the research projects that best meet the agreed priorities and are within budget
- Grant agreements will be made institutionally to the member organisation as a package of several grants,
- Funds will be managed internally and disbursed to individual applicants of each proposal within a member organisation

Disbursement of funds

- Disbursement of funds will be authorized to member organisations of the FRDN
- Once a research proposal had been approved by the FRDN steering committee, a contract would be prepared where payments would be made in two installments. Each installment will be approved for the FRDN steering committee. The installments will include:
    1. 50% payment on the signing of the contract and delivering a workplan,
    2. 50% payment on production on the approval of the research report by FRDN committee.

Responsibility of the organisation funded by the mini-research funds

- It will be the responsibility of the organization coordinating the research to:
- Maintain a financial management system including original receipts, document records and accounts, in accordance with accounting standards acceptable to WorldFish;
- Prepare contract agreements for signing by Worldfish with those organizations that are responsible for overseeing the research and are approved by the FRDN steering committee;
- Work with the researcher to prepare and present a budget table and statement with costs listed under specific budget lines with a narrative explanation where necessary.
- The budget will include the following item allocations:
  - (1) consultancies (specialist used for an activity within the study);
  - (2) DSA (fees for work in the field to cover all food and accommodation costs with no receipts required);
  - (3) travel (narrative description of the transport used and would not require a receipt accept for larger payments such as vehicle hire);
  - (4) materials and equipment;
  - (5) overheads (institutional costs such as photocopying, printing, use of meeting venues).

Conflict resolution

- The decision-making process of the FRDN Steering Committee is via consensus to approve all funds
- If the FRDN steering committee cannot agree to approve a project proposal by consensus then the project should be reformulated until consensus is reached

Review of project proposals

- The member organizations will review short-listed projects by reviewing collectively the projects using the questions below as a guide

Title:

Researcher:

Organisation:

The Project:

1. Does this project achieve or contribute to achieving any of the ACIAR Project Objectives?

2. Will the researcher be able to achieve the outputs described in the time allocated?

3. Will the proposed research activities duplicate any ongoing or proposed projects (undertaken by your organization or other organizations)?

Budget

1. Will the researchers be able to complete the project with the funds requested, and is the amount requested for this project reasonable?

2. Are there any parts of the budget that are reason for concern? Which ones and why?

Recommendation

1. Should this proposal be rejected or supported? Why?

2. If the project should be supported, should there be any changes or conditions?

Application form

- The application form for funding should be developed into a 2-3 page proposal with a budget

Application form
Provide an overview of the project concept. It is typically 2-3 pages in length, and must include at least the following information: **Project Rationale** – Describe what the main research question and how the project will contribute to the ACIAR Project Objectives and priorities identified in the call for proposals. What is the aim and objectives of the research project? **Project Approach** – Describe the proposed methodology and actions of your research project will take to address research question. What will you do and how will you go about it? Include the expected results of the project and any potential risks you face in implementing the research. (no more than 500 words) **Link to ACIAR Investment Strategy** – How does your project relate to the ACIAR investment ? **Project Partners / Stakeholders** – List any partners that will be directly involved in implementing this research project as well as important stakeholders and beneficiaries and how you have involved them in your planning and implementation. **Impacts** – Describe how the research and results will impact on fishery resources and/or beneficiaries and describe how you will monitor or measure these impacts. **Project Budget** – Provide a breakdown of the proposed budget (in US$ or Kjats using the following categories. • (1) consultancies (specialist used for an activity within the study); • (2) DSA (fees for work in the field to cover all food and accommodation costs with no receipts required); • (3) travel (narrative description of the transport used and would not require a receipt accept for larger payments such as vehicle hire); • (4) materials and equipment; • (5) overheads (institutional costs such as photocopying, printing, use of meeting venues).

23rd May, 2013

Call for Mini-Research Proposals in the Myanmar Inland and Coastal Fishery Sector – Ayeyarwady Delta

The ACIAR funded Project '*Improving Research and Development in Myanmar Inland and Coastal Fishery*' or **MYFish** is supporting the development of the **Fishery Research and Development Network (FRDN).** The FRDN is a network of researchers, development practitioners and extension officers from the Department of Fishery (DoF), Myanmar Fishery Federation (MFF), Universities from Yangon and Ayeyarwady, the Food Security Working Group (FSWG) and WorldFish.

The **aim of the FRDN is to strengthen the research and development capacity of the fishery sector** and it does this by providing mini-research grants to researchers, development practitioners and extension officers to undertake research in specific topics of interest to the FRDN.

The FRDN is managed by a committee that includes two representatives from each of the Myanmar organizations (DoF, MFF, Universities, FSWG) and WorldFish. The **FRDN committee is responsible for screening and approving the small-research grants proposals** from members of each of the organizations.

This is the first call for proposals issued by the FRDN commitee. The **deadline for receipts of propsals is Monday 15th July** and proposals should be submited to their respective FRDN committee representative. Applicants are encouraged to meet and discuss their propsal with their committee member representative and submit their prpoposals prior to the deadline in order that review and processing of applications can begin sooner.

The proposal for this first call should cover the **geographical area of the Ayeywardy Delta Region** and address gaps in knowledge on livelihoods, food and nutrition security, markets and value chains.

It is important that the applicants communicate their intension to **submit a proposal to their FRDN committee member representative** so that the proposal meets the aims and objectives of this call. Any proposals that are submitted directly to the MYFish Project Office will not be accepted.

Applicants are encouraged to familiarize themselves with **MYFish Project aims and objectives** - a summary document is available from FRDN committee members and MYFish Project Office.

Eligibility is restricted to any member of the FRDN for this first call: DoF staff that work in the Ayeyarwady Delta at Township, District or Regional levels; students and researchers from Universities from Yangon and Ayeyarwady; MFF staff that work in the Ayeyarwady Delta; and any member of the FSWG.

Research challenges, objectives and suggested projects

A large proportion of the poor in the Ayeyarwady Delta are dependent on fish for food and nutrition security and on the fish value chains (processing, transport, selling) for their livelihoods.

Although there have been several interventions in the Delta particularly after cyclone Nargis, child malnutrition is high and there is still limited knowledge about the fish consumption patterns for different households as well as the contribution of fish to food and nutrition security in different zones of Delta. Generally, the production data is also underestimated as the fish consumed domestically is not accounted for.

The fish value chains in the Delta are well established and are based on strong social networks and trust-based relationships. Fishers sell mainly to the same traders who often provide loans and maintain buyer-seller dependency. Many of the poor are engaged in wage labour in different parts of the value chain and whilst this provides people with regular although seasonal employment and contributes to their livelihoods, they are caught in a poverty trap.

Continued engagement of the poor in this lifestyle will not contribute to bringing people or their children out of poverty and they will continue to be marginalized due to several factors, most important being their limited access to natural resources, technologies, capital markets, credit, motorized transport and, low level of skills. The ability of these households to accumulate assets (social, human, financial, physical and natural capitals) is critical to participating and benefiting from value chains and markets and optimizing fish for food and nutrition security.

This call for proposals is interested in research projects that address these concerns and the following challenges and objectives listed below. Research that involves collaboration between different FRDN member organizations and are designed to cover a range of different agro-ecological zones (fresh, brackish and marine waters) will be reviewed favorably.

Livelihoods, gender & poverty

Challenges

- There appears to be a limited and declining range of livelihood options and choices for poor men and women in the Delta due to poor asset ownership (i.e. fishing gear. boats, and post-harvest equipment)
- Heavy dependence on wage-labour for livelihoods and incomes are inadequate for many households

Research objectives

- Improve the range and quality of livelihood choices for poorer households (particularly those without access to land or a boat) so they could benefit more from fisheries and aquatic-agricultural systems (AAS).
- Improve the asset accumulation capability of poorer households to become more resilient and be able to cope with disasters and change.

Suggested research projects

- Household and community surveys using different participatory methods to assess livelihood strategies and the value of assets for men and women in different types of households and agro-ecological areas
- Mapping of livelihood interventions in the Delta (who is doing what and where)

Food and Nutrition Security

Challenges
- Limited dietary diversity and quality leading to poor nutrition and health amongst households, especially children.

Research Objectives
- Improve the contribution of fisheries and fish products to food and nutrition security in different areas of the Delta.

Suggested research projects
- Community and household surveys to assess consumption and nutrition patterns for fish and fish products in different types of households and in different agro-ecological zones
- Mapping of food security and nutrition interventions in the Delta (who is doing what and where)
- Characterizing food security and nutrition interventions according to their benefits (i.e. access to food, food use and food stability)

Markets and value chains

Challenges
- Apparent limited attempts to promote small-scale value addition enterprises in fisheries to diversify products, and out scale successful enterprise models
- A lack of small-scale fish processor organizations (groups/cooperatives) to produce quality outputs to meet demand.
- The potential of fisheries and aquaculture throughout its value chain to provide opportunities for seasonal employment and income generation for unskilled labour force in the Delta is not fully explored

Research Objectives
- Improve the role and benefits of poor households from involvement in fish and fish product value chains
- Identify the most effective entry points for improving performance of the chain and benefits to the poor in the chain

Suggested research projects:

- Characterizing the fish and fish product market and value chain using participatory methods to identify seasonality of production and market demand, transport routes to markets, number of steps in the marketing chain and the stakeholders involved in each step, consumer preferences, quality and price relationships, credit arrangements
- Assessing where in the fisheries value chain improvements can be made to improve the benefits captured by the poor, and what fish and fish products are priorities for supporting poor households

The application forms for the research proposals can be obtained from your organization's FRDN committee member representative and should be completed with the support of the committee representative.

For further details please contact the FRDN Grants Officer on Tel: 01 647 520 at the MYFish Project Office, Department of Fisheries (DoF) Bayint Naung Road, Insein Tsp, Yangon. Focal points for the FRDN member organization are as follows:

- Dr. Htun Thein, Department of Fisheries: htunthein.akyab@gmail.com
- U Soe Tun, Myanmar Fisheries Federation: nyeinst@gmail.com
- Dr. Min Ko Ko Maung, Food Security Working Group: fswg.deputycoordinator@gmail.com
- Xavier Tezzo, Technical Support Officer, WorldFish: 01 647 520 (after June 1st)

11.3 Appendix 3: Example of a research protocol for the Department of Fishery Activity Working Group (AWG) pilot

Title of pilot
Experimental grow-out of Swamp *Eel Monopterus albus* in DOF Fisheries Station, Pantanaw, AD Region)
Project Rationale – Describe how the project will contribute to the MYFish Project Objectives and priorities identified in the call for proposals. What is the aim and objectives of your research project?
Freshwater eels of *Monopterus* species are among the high demand species for export market in Myanmar. Especially to China and Taiwan from Myanmar. Thus, farmers have been attempted to grow out baby eels collected from the natural, however no tangible grow out methods have been established yet MYFish AWG (aquaculture team) had attempted swamp eel grow out in Laydaukkan DOF Fisheries Station in 2015 February to August with 5 earthen pit of (20 x 12 x 3) feet lining with water proof lining, in which the earthen bed of (18 x 9 x 3) feet with submerge weeds and plants. The outcomes indicated the potential of growth and better yield in six months period if the routine harvest period could be determined. During this research period feeding was provided with locally available. This objective of this proposal is to further verify eel grow out in the bamboo and netting cages with different stocking densities, feeding and times to harvest.
Project Approach – Describe the proposed methodology and actions your research project will take to address the aim and objective of your research. Include the expected results of the project (no more than 500 words).
The project implement would be as the following- **Project site:** Pantanaw DoF Station in Ayeyarwady Delta **Project period:** March to June (4) months in 2016. **Grow out system:** twelve cages of (6 x6 x3) feet made of bamboo and bamboo and netting materials would be stationed in the earth ponds of (60x 25 x 5) feet. **Stocking densities:** Ten kilograms baby eels of 15-20 grams would be stocking in every each cages. **Feed:** mixture of trash fish / fish offal discard from processing, boiled broken rice, peanut cakes and feed additives. Two types of feed would be formulated based on the composition of trash fish / fish offal. **Feeding :** Two types of feed would be formulated **Feeding Type A** - 80% trash fish, 19% boiled rice and 1% feed additive. **Feeding type B** -60% trash fish, 39% boiled rice and 1% feed additive. Trash fish / offal would be obtained from fish processing factories in Yangon. **Harvesting:** 2-months for 4 pond, 3-months for 4 pond and 4-months for 4 pond Data collection: Monthly data collection would be carried out for the growth, survival and feed conversion estimation along with the phisico-chemical parameters of the pond water. Close monitoring and daily management: Would be conducted with staff from DOF Fisheries Stations with the guidance of WorldFish experts.
Project Partners / Stakeholders – List any partners that will be directly involved in implementing this research project as well as important stakeholders and beneficiaries and how you have involved them in your planning and implementation.
Department of Fisheries (DoF): PantanawDOF station manager and all of staffs will participate on the whole series of eel culture program with MYFish AWG team.
Benefits – Describe how the research and results will benefit fishery resources and stakeholders.
The provided inputs will guarantee an extra source of income to the farmer, which is an interesting development and is not so surprising given the high market value of these eels in township market. It is recommended that this model be investigated to assess its productive nature and economic viability before being further extended further to fishers and farmers. Eel culture system does not require the conversion of agricultural land and can be set up very close to the homestead to ensure security. System like this would suit small-scale fishers who have daily access to small amount of trash fish. In this way this system could be seen as converting low value waste from the fishery, into a high value crop.

Workplan – timeframe of research with specific events and outputs of deliverables

Activities	2016									
	Mar	April	May	June	July	Aug	Sep	Oct	Nov	
Pond Preparation										
Eel stocking										
Grow out culture										
M&E										
Harvesting										
Report writing										

Project Budget – Provide a breakdown of the proposed budget (US$) using the following categories

Activities	Unit Price	Quantity	Cost (USD)	Code
1 .Travel to survey				
i. DSA for survey team (2 person)	20/day	6 days	240	N-005
ii. DSA for Driver (1 person)	10/ day	6 days	60	
iii. Transportation (fuel)	35/day	6 days	210	
2. Pond preparation(20'x60'x4')	150/pond	2 ponds	300	
3. Pond set up (Bamboo cage)	50/pond	6 ponds	300	
4. Pond set up (Net)	75/pond	6 ponds	450	
5. Eel fingerling cost	5/viss	75 viss	375	
6. Supplementary Feed	70/month	4 months	280	
7. Consultancy Fees	Lump		500	
8. Labour charges	20/person	2 person (4 months)	160	
9. Submersible pump	150	1	150	
10. Miscellaneous			500	
Grand Total			**3525**	

11.4 Appendix 4: Summary tables of thematic group discussions - impact pathway workshop

Thematic	Key Findings	Next Users	Expected Changes	End Users	Expected Changes	Research Areas	Activity/Pilots
Value Chain	If the value chain is shorter (less actors/links), the small scale fishermen have higher profits.	Fisheries Workers (INGO/LNGOs)/CBOs	Supporting and implementing research on VC	Fisheries communities	Better access to the end market and generate better income from their activity.	> Assessment of existing microfinance opportunities (formal/informal) for small scale fishermen and fish farmers > Production and consumption patterns of fish products in Myanmar and studies exploring the impact of fish consumption for food and nutrition security of vulnerable	> Piloting Fisheries cooperation/producers cluster for joint marketing initiative
	High price of fish products is due to poor road infrastructure in productive area.	Policy Makers	Better inter-Ministerial coordination (e.g. MOLFRD and Planning) supports road connectivity to productive areas (part of the Rural Development strategy)	Fishermen/Traders/ Wholesalers	Low transport cost and increased profit		

		Universities/ Researchers	To investigate further on the impact of road infrastructure (transportation costs) on the price of fish products	Policy Makers	Better awareness of the extent of infrastructure constraints and identification of challenging areas	households > Studies investigating the impact of road infrastructure on the price of fish products	
		Fisheries Workers (INGO/LNGOs)/CBOs	To pilot and promote organization of producers into fisheries communities/cluster at grassroots level (including post- harvest technology)	Consumers/ vulnerable households	Can access fish products at reduced price (food and nutrition security impact)		

Thematic	Key Findings	Next Users	Expected Changes	End Users	Expected Changes	Research Areas	Activity/Pilots
Livelihood, Food and Nutrition Security	Fishermen involved in different livelihoods usually own lands and are better off than people who only do fishing	Village Heads, Village Development Committees	Active participation and cooperation in identifying livelihoods opportunities	Fisheries Workers (INGO/ LNGOs)/ CBOs	Have a better understanding of fisheries communities livelihoods and potential alternatives	> Mapping of current Health/WASH/Education related interventions with a focus on the coverage of fisheries communities (and the impact of interventions) > Investigating the potential of small-scale aquaculture as an alternative livelihood (closed season) for fisheries communities	> Awareness raising/training for improved hygiene practices (e.g. WASH) in fisheries communities > Nutrition-related education program on the importance and benefits of fish in the household diet (e.g. Maternal health care)
		Universities/ Researchers	More research is focusing on livelihood and market opportunities for fisheries communities	Department of Fisheries/ Policy makers			
		Department of Fisheries/ Policy makers	Policy is enabling for small scale fisheries communities to diversify their livelihoods	Fisheries communities	Increase their income by diversifying their competencies and livelihood		
		Fisheries Workers (INGO/ LNGOs)/CBOs	Deliver tailored financial and technical support (e.g. microfinance, vocational trainings)				
	Fisheries communities in AD have poorer living	Policy Makers	Better awareness and policy enabling fisheries	Fisheries communities	Increase their living standard/educatio		

	conditions and lower education levels than other livelihoods		communities to raise their living standards		n hygiene		
		Fisheries Workers (INGO/ LNGOs)/CBOs	Tailored-interventions towards the improvement of living standards of fisheries communities (Education, WASH, etc.)				
		Universities/ Researchers	More research is looking at characterizing living conditions, education levels of fisheries communities				

Thematic	Key Findings	Next Users	Expected Changes	End Users	Expected Changes	Research Areas	Activity/Pilots
Capture Fisheries (Fisheries and supporting ecosystem resources)	Electric fishing threatens fisheries sustainability	Villagers/ Farmers	Better awareness and help preventing it	Fisheries communities	Sustainable fish resources	> Studies investigating the extent of electric fishing practices. > Biodiversity assessment of water bodies in collaboration with stakeholders, Universities, DOF and INGOs	> Awareness campaigns on the harmful effects of electric fishing and promotion of sustainable fisheries practices. >Work with DoF and fisheries communities to identify spawning sites in Delta and piloting co-management approaches
		Department of Fisheries/ Policy makers	Better understanding of the problem/ Collaboration with the private sector	Fisheries communities	Alternative livelihoods		
	Possibility to implement biodiversity assessment through gathering of local knowledge	Fisheries Workers (INGO/ LNGOs)/ CBOs	Introduce tailored research methodologies and build capacity of research teams	Fisheries communities	Better involvement in fisheries management		
		Fisheries communities	Take part in sustainable management of fisheries	Department of Fisheries/ Policy makers	Better informed management and stock enhancement practices		
		Universities/ Researchers	Implement Applied Research Dev. More reliable fisheries data	Fisheries Workers (INGO/ LNGOs)/ CBOs	Better knowledge of fisheries resources		
Aquaculture (Production System)	Opportunity to develop aquaculture in low water-availability areas	Fisheries Workers (INGO/LNGOs)/CBOs	Identify/adapt suitable technology	Agricultural farmers/ villagers	Increase income (poverty alleviation) and food and nutrition security through fish farming	> Current status of eel (M. albus) natural stocks, sustainability of wild seed collection and scope for artificial breeding > Current production and market of cultured eel in Myanmar	> Promote information exchange about suitable aquaculture technologies for low water availability areas between Fisheries Workers (INGO/LNGOs), DoF, Universities, VDC and Villagers (Knowledge Fairs) >Piloting of WISH pond/ Cage Culture and eel farming