# Managing Aquatic Agricultural Systems to Improve Nutrition and Livelihoods in Selected Asian and African Countries: Scaling Learning from IFAD-WorldFish Collaboration in Bangladesh

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## 2019 Technical Report

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# 1 BACKGROUND

The Aquaculture and Fisheries/Agriculture-Nutrition Linkages approach was first introduced in Bangladesh through the IFAD-funded WorldFish '*Small Fish for Nutrition*' project from 2010 to 2013, whereby the innovative technologies for production of carp and other micronutrient-rich small fish species were refined and integrated through community-based sustainable wetlands. The project focused on aspects including the increased production and productivity of fish, and consumption of micronutrient-rich small fish in the first 1,000 days of life (a critical stage of child development from conception to two years of age). The approaches introduced engaged both men and women in agricultural production systems; combined innovative technologies and behaviour change communication (BCC) methods as tools in achieving desired outputs in community, family and individual levels. The implementation had resulted in further scaling up exercises to reach 200,000 households in 6 years and the enhanced stocking of small fish species in 200 bodies, and these were done in collaboration with other partner agencies. WorldFish and the Ministry of Fisheries and Livestock had also produced policy briefs, brochures, a TV spot, radio programs, and held workshops and training sessions to implement this aquaculture and fisheries/agriculture-nutrition linkages approach in Bangladesh.

Building on the success and growing interest from the implementation of the approach in Bangladesh, this project was developed with the aim to scale up and implement similar approaches in other aquatic agricultural systems, in selected countries where fisheries resources have significant potential to improve nutrition and livelihoods. Three countries were selected for this project namely Cambodia, Zambia and Indonesia.

- Cambodia – The rural populations of Cambodia is highly dependent on aquatic agricultural systems and small fish can provide an important animal-sourced food, supplying essential micronutrients and animal protein to the diet. However, the dietary diversity of Cambodia is low, and the increase of fish production and productivity can contribute to the improved nutrition and livelihoods in Cambodia
- Zambia – In the Barotse Floodplain, an estimated 70,000 people depend on the resources of the floodplain for their livelihoods and food. Ineffective management of the plains, together with increasing fishing pressure, environmental degradation and climate change had resulted in the dwindling stocks of the floodplains. The technology on community-based sustainable wetlands management and enhanced stocking, as developed in Bangladesh, has been identified as means to improve fish stock. Pond polyculture technology, with large fish and small fish stocked in the same pond, were also adapted for scaling up in the Northern Province of Zambia.
- Indonesia – Strong national sectors drive the aquaculture and fisheries production for urban markets and exports, and yet areas with marginalized, poor rural populations and fisheries resources exist. This project was aimed at engaging partners to advocate for scaling up of the nutrition-sensitive aquaculture and fisheries approach for strengthening efforts to improve nutrition, especially for poor women and children.

Four outcomes were identified from the project and are as follows:

- Increase availability, access and consumption of micronutrient-rich small fish and vegetables in targeted population groups in the selected countries;
- Improved gender equity and women's empowerment, especially regarding intra-household food intake, agricultural practices and work load;
- Increased knowledge, awareness and training of government, national and NGO partners in integrated aquaculture and fisheries/agriculture-nutrition linkages approach for influencing policies and implementing interventions for scaling up; and
- Strong regional and national partnerships and collaboration for adoption and dissemination of the aquaculture and fisheries/agriculture-nutrition linkages approach.

These major outputs were expected from the implementation of the project:

- Pond polyculture of large and small fish developed and expanded in 3,000 households; community-based wetlands management developed and expanded, benefitting 1,000 households; all leading to increased production of and access to fish;
- Micronutrient-rich vegetable production on dykes and homestead gardens developed an expanded in 4,000 households, leading to increased production of and access to vegetables;
- Behaviour change communication (BCC) and nutrition education reach women and other family members in 4,000 households, leading to increased consumption of small fish and vegetables, especially among women and young children; and
- Fish production technologies and the importance of small fish for improved nutrition information disseminated and influence policy formulation in Cambodia, Zambia and Indonesia through three policy briefs for Africa and Asia, one peer-reviewed journal article, proceedings from one national workshop in Cambodia and one in Zambia, and participation of key country partner(s) in one relevant regional workshop.

The estimates presented in the above outputs are based on the experience from the "*Small Fish for Nutrition"* project carried out in Bangladesh. The difference between Bangladesh with Cambodia and Zambia, for example, with respect to the specific conditions of pond polyculture and wetlands management in the selected areas, may lead to large variations in increasing production and consumption of small fish and vegetables. As described, the level of engagement in Indonesia will be through regional partners and may lead to lesser or greater degree of dissemination as initially projected.

# 2 OVERALL PROJECT GOALS AND OBJECTIVES

The overall goal of the project is to improve nutrition and livelihoods of poor, rural households in aquatic agricultural systems in Cambodia, Zambia and Indonesia through increased intakes of micronutrient-rich small fish and vegetables from own production, as well as through increased household income.

The objective of the project is to scale up the integrated Aquaculture and Fisheries/Agriculture-Nutrition Linkages approaches, developed and practiced in Bangladesh, in targeted communities of the selected countries by improving production and productivity of household ponds and dykes; increasing small fish production and fish species diversity in wetlands; and supporting initiatives to increase consumption of micronutrient-rich small fish and vegetables.

# 3 CAMBODIA COMPONENT

## 3.1 SUMMARY AND CONTEXT

Over the past decade, Cambodia has enjoyed strong economic growth resulting in improved livelihood for its population of 14 million. Despite significant progress, 4.8 million Cambodians remain poor, with 90% living in rural areas. Subsistence farmers, members of poor fishing communities, landless people and rural youth makes up the majority of Cambodia's poor. Generally, this demographic does not have enough food to eat for the whole year, dietary diversity is low, and malnutrition remains high among children under five years of age.

Fish is an integral part of Cambodia's culture, economy, and food security, contributing to around 7% of national GDP and supplying 66.3% of households' animal protein intake. Yet, the diet of many rural Cambodians remains heavily dependent on staple foods such as rice, and dietary diversity remains low. Increasing fish production and productivity, in particular the small indigenous fish species, by using the integrated Aquaculture/Agriculture-Nutrition Linkages approach, can provide smallholder households with increased income and support food and nutrition security.

Household aquaculture ponds stocked with both larger, marketable fish and small, nutrient-rich fish species can be managed with limited inputs to generate extra income for households and provide additional nutrient-rich food supply to households over an extended period of the year. In addition, ponds can be integrated into the smallholder's farming system, providing water for homestead vegetable production on pond embankments. This integrated approach has the potential to help address the constraints faced by many rural Cambodians and improve livelihoods and nutritional outcomes.

## 3.2 ACTUAL RESULTS

Below we present the achievement of the project in 2019 and 2020 toward the four outputs listed in the project LogFrame:

- Increased availability, access and consumption of micronutrient-rich small fish and vegetables in targeted population groups in the selected provinces;
- Improved gender equity and women's empowerment, especially regarding intra-household food intake, agricultural practices and work load;
- Increased knowledge, awareness and training of government, national and NGO partners in integrated aquaculture and fisheries/agriculture-nutrition linkages approach for influencing policies and implementing interventions for scaling up;
- Strong regional and national partnerships and collaboration for adoption and dissemination of the aquaculture and fisheries/agriculture-nutrition linkages approach.

### 3.2.1 Output 1: Increased availability, access and consumption of micronutrient-rich small fish and vegetables

#### *3.2.1.1 Activity 1: Aquaculture and horticulture production*

For 2019, we report a single cycle of production from the period of September 2018 until June-August 2019. As done in 2017, the selected households for the second cycle are within the same communes with another WorldFish-led project (Rice Field Fisheries project, USAID funded) to create synergies between projects. In addition new communes have been added to extend the number of beneficiaries for this production cycle.

1st Cycle: 2018-2019

From August 2018, additional households have been selected in new villages and communes within the 3 provinces for both homestead and rice field ponds interventions and horticulture production (Table 1).

*Table 1: Project beneficiary's administrative location for the growing season starting in August 2018 (HH: households)*

| *Province* | *District* | *Commune* | *Village* | *HH – Homestead pond* | *HH-Rice field pond* | *Vegetable garden* |
|---|---|---|---|---|---|---|
| Battambang | Bovel | Kdol Tahen | Tuol Krasaing | 5 | - | 5 |
| | | Khlaing Meas | Along Raing | 4 | - | 4 |
| | Thmor Kaul | Ou Taky | Trash | 1 | 2 | 3 |
| | | | Ou Taki | 3 | - | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | Popeal Khae | 5 | 3 | 8 |
| | Moung Reusey | Kakoh | Chork Thom | 17 | - | 17 |
| | Sangke | Raing Kesey | Voat Kandal | 16 | 5 | 21 |
| Siem Reap | Kralanh | Kralanh | Kralanh | 7 | 2 | 9 |
| | | | O'Kralanh | 12 | 3 | 15 |
| | | Sranal | Sranal | 17 | 3 | 20 |
| | | | Lahong | 5 | - | 5 |
| | | Rong Ko | Bos Thom | 7 | - | 7 |
| | Pouk | Prey Chrouk | Doun Tok | 1 | - | 1 |
| | | | Keta Yaus | 3 | | 3 |
| | | | Prey Chrouk | 4 | 1 | 5 |
| | | | Phlang | 2 | - | 2 |
| | Sotr Nikum | Khchas | Khchas | 3 | - | 3 |
| | | | Thmey | 12 | 2 | 14 |
| | | Dan Run | Santey | 6 | 5 | 11 |
| Pursat | Krakor | Sna Ansa | Veal Vong | 4 | - | 4 |
| | | | Ansa Kdam | 3 | - | 3 |
| | | Anlong Tnoat | Thkoul Thom | 8 | - | 8 |
| | | | Papet | 2 | - | 2 |
| | | Tnoat Chum | Prey Khla | 0 | 7 | 7 |
| | | Ansa Chambak | Kchach Laet | 15 | - | 15 |
| | | Kbal Trach | Kralanh | 7 | - | 7 |
| | | | Daung | 8 | - | 8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Phnom Krvanh | Phteah Rung | Batromduol | 1 | - | 1 |
| | | | Kandal | 1 | - | 1 |
| | | | Phteah Rung | 5 | - | 5 |
| | | Pro Ngil | Kampeng | 8 | - | 8 |
| | | | Ousrav | 5 | - | 5 |
| | | Santrie | Srae Porpeay | 9 | - | 9 |
| | Bakan | Rumlech | Pralay Romdeng | 9 | - | 9 |
| | Talou Senchey | Phteah Rung | Phteah Rung | 5 | - | 5 |
| | | | Kandal | 1 | - | 1 |
| | | | Batromduol | 1 | - | 1 |
| **TOTAL** | | | | **222** | **33** | **255** |

Before stocking in 2018, 36 ponds and 8 rice field ponds have been renovated, deepened and the height of the dykes raised. The stocking was spread from August to December 2018, with stocking according to the water level in the floodplain and availability of fingerlings.

Compared to 2018, 303 farmers were identified. However, 48 farmers dropped out or decided not to stock fish due to two main reasons: other livelihood opportunity (mostly migration outside of the village) or lack of water.

*Capacity building*

In 2019, the Fisheries Administration (FiA) did not provide any training to NGOs technicians. FiA trained the technician before the start of the cropping season in 2018. In 2019, FiA supported producers with 191 on-site visits at the farms for both homestead and rice field ponds in each province to monitor fish culture and provide technical support to local partners.

The aquaculture technicians (local NGO partners) provided technical support to 270 farmers, with a total of 1,433 visits, including the 191 visit conducted in collaboration with the FiA. Each farmer received in average 3 to 4 visit in 2019, corresponding to visit every 5 weeks. The support also included short thematic trainings conducted at the lead farmer location in the target intervention communes and one day workshop training on aquaculture technique in each province. In addition, in Siem Reap 4 farmers received a specific training for duck weed – an aquatic plant to feed fish. Two intra-province farmers exchange (51 participants, including 13 women) were conducted in Siem Reap province.

*Photo: left: Fisheries Administration officer checking water temperature in pond; right: Water quality training (Secchi disk) in Battambang province*

Monitoring and support of horticulture activities are performed in collaboration with the Rice Field Fisheries II project (USAID funded), occurring in the same communities. Vegetable production happen next to the homestead ponds and rice field ponds, using water from the pond. In 2019, vegetable production occurred in the dry season from January to July, the production decrease with the start of the rain. The second season was not supported by the project, as activities stopped in September 2019.

The project did not modify protocol and support to beneficiaries compared to 2017 and 2018. The beneficiaries received in-kind support after a training conducted at the community. In 2019, 117 farmers received vegetable training on home gardens and compost production and, received inputs to start vegetable production. In total, 270 farmers are growing vegetables nearby their pond. The technicians conducted 1,021 visits to homestead gardens in 2019. The project conducted eleven trainings on vegetable production and train 146 farmers.

*Technical dimension of nutrition-sensitive aquaculture*

In 2019, there was limited input support to producers as most of the stocking happened in 2018. In total 84 farmers received fingerlings in Siem Reap and Battambang to stock in homestead ponds and rice field ponds.

We promoted fish polyculture for income generation stocked at 5 fish per square meter and additional stocking of nutrient-rich fish collected in rice field for family consumption. For the second cycle, the species assemblages was modified. Common carps was excluded due to low market demand. Farmers preferred to stock tilapia and snakeskin gourami, with silver barb, silver carp and Indian carp for 230 HH. Fifteen farmers in Siem Reap and Pursat provinces tested assemblage with only silver barb (40%) snakeskin gourami (55%) and tilapia (5%). Finally nineteen household added to the later assemblage 15% of Trey riel top (*Cirrhinus siamensis*), while reducing to 40% the ratio of silver barb and gourami.

In 2018, the density of SIS was doubled from 500 grams per $100m^2$ to 1 kg per $100m^2$. The modification of the species assemblage was the outcome of the annual reflection workshop held in Battambang in June 2018. The project aimed at developing a low cost affordable technology, therefore feeding system of the pond is based on locally available food and on green water technology, enhancing natural productivity of the pond. However some farmers chose to invest in commercial pelleted feed, at higher cost. In 2019, aquaculture activities focused on water quality monitoring, improving feed management and recording of activities and harvest.

In homestead pond, the stocking started from August and September 2018, and late stocking still happened until January 2019. Sequential harvest started in January and lasted until July, with a peak harvest in March, April and May 2019.

Rice field ponds production cycle started from December 2018 to January 2019 and grow-out continued until July 2019, with sequential harvest starting from April-May 2018. Similar stocking density and species assemblage was applied in rice field ponds than in homestead ponds.

*Input support*

In 2019, 84 households received in-kind support to start nutrition-sensitive aquaculture. A total of 48,017 silver barb, silver carp, Indian carp and tilapia were distributed to 84 farmers. In addition, 261 kg of SIS was provided, as in 2018/2019, the flood extend was limited hindering access to SIS by farmers. The SIS distribution system tested in 2018 was not effective in 2019 due to the limited availability of SIS. Additional SIS were sourced from local fishermen and transported to ponds, in Battambang and Siem Reap provinces to reach the decided stocking density. In Pursat, 41 homestead ponds and 9 rice field ponds could not stock the adequate density of SIS. In Battambnag, due to limited flood, 26 producers could not stock SIS adequately.

In addition, 71 gill net to harvest SIS and 43 Secchi disk to monitor water turbidity were distributed. Farmers also contributed to the intervention by providing labour force to construct composter and upgrading pond flood protection system.

In 2019 the project supported 117 micro and home garden for vegetable production by providing gardening materials[1] and seeds such as long bean, pumpkin, amaranth, bitter gourd and water spinach. However, these gardens were not established on dykes by the ponds as they are often too small and narrow, but instead the gardens area built in locations next to the pond.

*Photo: left: fthe pond in Battambang province; right: Mrs. Chhorm Maly is a farmer was harvesting the small fish at Tuol Krasang Village (Battambang province)*

[1] Fencing, plastic, watering cans, hand sprayer

*Progress toward indicators*

The monitoring system is based on logbook updated daily by farmers and monitored and captured on a regular basis (at least monthly) by aquaculture technician on electronic format. The monitoring variables include: inputs and outputs of pond and plots and destination of the production. In parallel, technicians visiting the households are recording their observation about fish and vegetable farming. In September 2018 vegetable farming production was added to the weekly monitoring. Nutrition outcomes is assessed using the monitoring system for Nutrition and Hygiene (see section 2.1.2).

The production and economic results presented below are based on a sub-sample of the beneficiaries after cleaning the dataset. The production and economic outcomes are based on a sample of 116 homestead ponds and 15 rice field ponds. The production results of the first cycle are presented in Table 2.

*Table 2: Yield of homestead and rice field ponds (standard deviation in parenthesis).*

| | *Average size ($m^2$)* | *Total production ($kg/100m^2$)* | *Large Fish production ($kg/100m^2$)* | *SIS production ($kg/100m^2$)* |
|---|---|---|---|---|
| Homestead Ponds (n=116) | 308.16 ± 191.42 | 66.63 ± 50.05 | 62.98 ± 47.78 | 3.65 ± 2.97 |
| Rice Field Ponds (n=15) | 406.20 ± 188.97 | 20.24 ± 22.95 | 19.26 ± 21.98 | 0.98 ± 1.01 |

Results shows a great variability in production performances. With a large number of new beneficiaries techniques are not mastered yet. Size of fingerlings, water quality and feed management were observed as key parameters that influence yield. As in the first cycle of production, some of those ponds were affected by mass mortality events, after rainfall in early stage of the rainy season. As for the first cycle using commercial pellet did not resulted in higher yield. A significant correlation ($P<0.05$) was observed between final yield and investment in pond preparation, showing that significant improvement can be achieved with proper pond preparation. Compare to the first cycle, the total productivity increased in homestead ponds from 30 $kg/100m^2$ to 66 $kg/100m^2$, including an increase of large commercial fish and SIS. The increase stocking density of SIS resulted in an increase of SIS productivity. This pattern was not observed in the rice field ponds.

Rice field ponds present a lower productivity than homestead pond. This results from the difficulties of removing predatory fish in rice field ponds before stocking commercial fish and SIS. In average 53% of the SIS and 37% of the commercial fish produced were consumed by the households, corresponding to a household's consumption of 4.3 kg of SIS and 51.8 kg of commercial fish per cycle of production.

*Photos: Horticulture activities in Battambang province*

Economic return and benefits from those two production systems varies depending on the use commercial feed (high price). Table 3, summarized the results of the first production cycle, where "operational cost" include all costs related to pond preparation and pond management (feed, fertilizer, harvest). "Value of production" represents the economic value of the production, including the inputted value of harvested fish consumed by the household. The "net return" is the value of production minus the operational cost.

*Table 3: Economic results in Khmer Riels (KHR) of homestead and rice field ponds. Standard deviation in parenthesis. 1 $US = 4,100 KHR)*

| | *Operational cost (USD/100m2)* | *Value of production (USD/100m$^2$)* | *Net Return (USD/HH)* |
|---|---|---|---|
| Homestead Ponds (n=116) | 64.94 ± 37.43 | 143.5 ± 103.95 | 78.50 ± 85.60 |
| Rice Field Ponds (n=15) | 25.66 ± 2.78 | 50.66 ± 58.58 | 24.9 ± 57.98 |

Higher economic results are achieved when the cost of commercial pellet is limited. Results shows that for the nine households using commercial pellets the net income per 100m$^2$ is reduced to 26.45 USD compared to 81.88 USD when using homemade feed. This shows that the use of commercial pellet does not results in higher economic performance due to misuse of commercial pellets.

Compared to the first, both homestead and rice pond performed better in terms of economic return, due to higher productivity, lower production cost with cheaper fingerlings and higher local retail price for the stocked species. Changing the species assemblage resulted in higher retail prices, varying from 2.25 USD/kg for silver barb, snakeskin gourami and tilapia.

The 236 households monitored for the vegetable production produced on average 103 kg of vegetable between January and September 2019 (end of the monitoring). Of this production, 20.7 kg was consumed directly by the household and the remaining harvest was sold locally or at the market. The average income per households was limited to 21 USD. Compared to 2018, the production per household is lower, however this results is explained by a change

in the monitoring system, with more precise recording of the production per type of vegetable, instead of an estimated of the production as previously.

#### *3.2.1.2 Activity 2: Nutrition and hygiene training*

In 2018, a baseline survey was undertaken to benchmark the access and consumption of fish and vegetable in the households. This baseline include also data collection on women and children nutrition. To monitor and asses changes, a 6-month periodic survey is schedule to monitoring the progress toward the target.

In 2019, the final survey take place in May 2019 corresponding to the last iteration and including all the households engaged in the project since 2017. The table 4 summarize the past monitoring survey, including the final survey.

*Table 4: Iteration of the periodic survey and different population surveyed*

| *Survey date* | *Sample / Population label* | *Survey and Iteration* |
|---|---|---|
| January 2018 | 76 HH / N1 | Survey1 - Baseline |
| May 2018 | 76 HH / N1<br>114 HH / N2 | S2 – Iteration 1<br>S2 - Baseline |
| November 2018 | 71 HH / N1<br>114 HH / N2<br>118 HH / N3 | S3 – Iteration 2<br>S3 – Iteration 1<br>S3 - Baseline |
| May 2019 | 71 HH / N1<br>112 HH / N2<br>113 HH / N3 | S4- Iteration 3<br>S4 – Iteration 2<br>S4 – Iteration 1 |

To estimate the effect of the intervention, we compared indicators within the same population sampled between baseline and the iterations. In 2019, the survey happened only in May, corresponding to the low season in terms of fish availability. We present in Table 5, the consumption indicators for the surveyed population in May 2018 and 2019, two comparable seasons.

*Table 5: Consumption of fish in population in N1, N2 and N3 populations in May 2018 (S2) and May 2019 (S4)*

| | S2 - Low Season 2018 | S4 – Low Season 2019 |
|---|---|---|
| Average consumption frequency of SIS in the last 7 days | N1: 2.65<br>N2: 2.73 | N1= 1.17<br>N2= 0.79<br>N3= 0.97 |
| Average weight (kg) of SIS consumed last 7 days per HH | N1: 1.03<br>N2: 1.37 | N1= 0.46<br>N2= 0.37<br>N3= 0.45 |
| Average consumption frequency of stocked fish last 7 days | N1: 9.36<br>N2 : 9.27 | N1= 6.9<br>N2= 7.0<br>N3= 7.0 |
| Average weight (kg) of stocked consumed last 7 days per HH | N1: 5.30<br>N2: 4.65 | N1= 3.6<br>N2= 3.8<br>N3= 4.0 |

The frequency of consumption is lower the second year of intervention, although production data shows that the productivity of the pond increase. The average weight of SIS consumed in the households in the last seven days significantly decreases between May 2018 and May 2019. This result could be the consequence of a lower impact of the nutritional training on newly recruited beneficiaries of the program. Similar trend is observed fort the commercial fish, with lest frequent consumption and lower amount consumed by the household in May 2019 compared to May 2018.

The monitoring system include behaviour changes in feeding habits and diets of children under 5 years old (Table 6) and mothers (Table 7).

*Table 6: Diet of children under 5 in N2 and N3 populations in May 2018 (S2) and May 2019 (S4)*

| | S2 - Low Season | S4 – High Season |
|---|---|---|
| Small fish preparation - % of households using it whole | N1: 8%<br>N2: 0% | N1: 9%<br>N2: 7%<br>N3: 11% |
| Average consumption frequency of SIS last 7 days | N1: 2.21(n=27)<br>N2: 2.51 (n=35) | N1: 2.1 (n=21)<br>N2: 2.3 (n=18)<br>N3:2.0 (n=29) |
| Average weight (g) of SIS consumed last 24 h | N1: 32.77 (n=26)<br>N2: 44.39 (n=18) | N1: 114.2 (n=21)<br>N2: 66.1 (n=18)<br>N3:70.5 (n=29) |
| Average consumption frequency of vegetable last 7 days | N1: 5.18 (n=40)<br>N2: 9.19 (n=59) | N1: 5.4 (n= 49)<br>N2: 5.4 (n= 57)<br>N3: 4.3 (n= 53) |
| Average weight (g) of vegetables consumed last 24 h | N1: 74.8 (n=35)<br>N2: 58.54 (n=50) | N1: 70.0 (n= 49)<br>N2: 56.4(n= 57)<br>N3: 67.7(n= 53) |

The average age to start feeding children with vegetable and fish remains stable between surveys S1, 2, 3 and 4 with more than 90% of the respondent start feeding their child between 6 to 12 months old with fish, vegetable. Although the project provided awareness raising on consumption and preparation of SIS, we observe that SIS are increasingly prepared and consume whole (with head and not eviscerate) for higher nutritional benefits. However the effect is not significant with only 9 to 11% of the households engaged in such practices. Most of the households still remove either guts and head or both before cooking the fish.

For mothers, the frequency of consumption as well as the average weight consumed is stable between 2018 and 2019. There is no cumulative effect of the project intervention in N1 population that receive 2 years of training and support. The frequency of vegetable consumption decreases in 2019, and there is no clear trend in the average intake of vegetable in 2019, with variable results across population.

The monitoring system faced several issues with a limited number of respondents especially the mother in charge of cooking. Most of the women are often migrating for off farm work, especially in the dry season limiting the accuracy of the responses. In addition, intervention took place in villages under the Rice Field Fisheries project where population received nutrition training since 2016, thus affecting the results of the baseline.

*Table 7: Diet of mothers in N2 and N3 populations in May 2018 (S2) and May 2019 (S4)*

| | S2 - Low Season | S4 – Low Season |
|---|---|---|
| Average Frequency of Consumption of SIS last 7 days | N1: 1.91 (n=23)<br>N2: 2.91 (n=23) | N1: 2 (n=16)<br>N2: 2.2 (n=15)<br>N3: 1.9(n=24) |
| Average weight (g) of SIS consumed last 24 h | N1: 23.80 (n=12)<br>N2: 125.71 (n=7) | N1: 92.5 (n=4)<br>N2: 107.5 (n=4)<br>N3: 76 (n=5) |
| Average Frequency of Consumption of vegetable last 7 days | N1: 15.44 (n=34)<br>N2: 9.43 (n=44) | N1: 6.2 (n=37)<br>N2: 5.2 (n=42)<br>N3: 4.4 (n=46) |
| Average weight (g) of vegetables consumed last 24 h | N1: 278.93 (n=34)<br>N2: 201.34 (n=41) | N1: 196 (n=27)<br>N2: 220 (n=30)<br>N3: 327 (n=37) |

### 3.2.2 Output 2: Improved gender equity and women's empowerment, especially regarding intra-household food intake, agricultural practices and work load

#### *3.2.2.1 Activity 1: Capacity building on nutrition and gender equity*

This activity aims at assessing in a participatory manner, the role and activity of households members and identify future actions to improve gender equity in terms of works load, agricultural activities and nutrition. In 2017, local partners received a training on Family Visioning and planning. Based on this knowledge, local partners supported 114 family visioning and 71 planning in 2019. The partners conducted 21 training on gender and women empowerment with a total of 173 participants of which 117 were women.

*Photo: Family visioning in Siem Reap province.*

*Progress toward indicators*

The project target that 75% of the women in targeted households report greater decision making. The 6-month periodic surveys and pond monitoring provide indicators about women empowerment, looking at their role in decision making regarding spending and investment. Intermediary results indicated:

- In homestead ponds and rice field ponds, of the 308 cash transaction related to marketing fish, 301 involved women. In May 2018, the proportion was lower with 54 transaction performed by women over a total number of transaction of 114.
- In May 2019, the cash generated by women during those transactions are estimated to be about 25 million riels (6,281 USD)
- Income from vegetable marketing was recorded to an average of 0.11 million KHR per households in the in May 2018. This increased to 0.32 million KHR in May 2019, of which 58% are directly managed by women.

Monitoring indicates that the interventions provide additional financial resources to the households and that this resource is managed by women.

### *3.2.3 Output 3: Increased knowledge, awareness and training of government and NGO partners in integrated aquaculture and agriculture-nutrition linkages approach for influencing policies and implementing interventions for scaling up*

#### *3.2.3.1 Activity 1: Local workshops*

In sections 2.1.and 2.2, we described the activities related to training of local partners and Fisheries Administration on Nutrition Sensitive aquaculture. Note that local partner provide training on nutrition village health support group. Both village health support group and local partners provide training to beneficiaries.

On December 4th 2019, WorldFish and FiA organized a final workshop in Phnom Penh. The workshop was divided into a morning session (National workshop- see section 2.4) and an afternoon session related to lessons learned and recommendations. The afternoon session included NGO partners. The workshop provided the opportunity to present and discuss results of project activities. The afternoon session involved 27 stakeholders from 4 main groups: 4 Fisheries Administration Cantonment Officers; 15 farmers (beneficiaries of the project) and hatcheries operators, 8 NGO partners.

The participants were divided into mixed groups and explored three themes:

- What are the five main constraints to continuing this nutrition sensitive production system after the closure of the project? And what are the potential solutions
- How to get access to quality fingerlings (commercial fish) and enough SIS?
- What are the key recommendations for future scaling of the technology?

Detailed outputs of the workshop are found in the workshop report.

*Photo: Multi-stakeholders group session discussing the three themes and reporting in plenary*

Each local partners organized an annual reflection workshop at the province. In Pursat the workshop included with 142 participants (52 women); in Siem Reap province included 97 participants (33 women) and 76 participants (42 women) in Battambang. WorldFish and local partners are part of the Scaling Up for Nutrition CSA network and participate to event organized by this network, presenting interventions and preliminary results. The activities related to this project was integrated in the inventory of nutrition sensitive intervention developed by SUN CSA Cambodia. On 30th July 2019, as a member of SUN CSA, prepare

booth in the World Breastfeeding Week in Siem Reap province to present about benefit of small fish, nutrition, and hygiene and joined in the a training on advocacy on nutrition.

On 10 and 11th July 2019, WorldFish organized a study tour in Takeo province to visit fish farms involved in more intensive production and rice-fish culture. The tour included 15 farmers, 6 NGO staff and 4 FiA staffs. Participants could learn on feeding technique and transportation of fingerings, key areas were improvement is required.

*Progress toward indicators*

National workshop organized in 2019 increased and facilitate knowledge sharing about nutrition sensitive approaches. It also help to develop network and linkages between farmers and private sector providing inputs for aquaculture.

### *3.2.4 Output 4: Strong regional and national partnerships and collaboration for adoption and dissemination of the aquaculture and fisheries/agriculture-nutrition linkages approach*

#### *3.2.4.1 Activity 1: Partnership and resource mobilization*

The project organized an international workshop with partners to strengthen partnership and engaged with non-direct stakeholders and local administration.

The workshop was held in Phnom Penh on 3rd December 2019, with presentations in a plenary session from Dr. Shakuntala Thilsted (WorldFish), Mr. Chin Da (vice director of the Department of Aquaculture Development (DAD), Fisheries Administration), Dr. Olivier Joffre (WorldFish) and Mr. Lyndon Paul, from Vissot, a social enterprise developing Ready to Use Therapeutic Food (RUTF).

Sixty eight participants attended the workshop, and they comprised of 14 NGO representatives, 4 donors and development agencies (USAID, JICA, GIZ and WFP), 7 students and representatives of universities and 8 government representatives from MAFF and Fisheries Administration, 3 private sector representatives, as well as 9 WorldFish staff and 15 farmers. We also had a delegation from Africa composed of representative of WorldFish Malawi, Lilongwe University of Agriculture and Natural Resources in Malawi; CSIR Water Research Institute from Ghana; IITA in Kenya, AfricaRice in Cotes D'Ivoire and private sector player from Ghana. Three representatives from Assam State in India, where WorldFish will deploy a similar approach, also attended the workshop.

After the opening remarks from the Vice Director of the Department of Aquaculture Development (DAD), Fisheries Administration, Dr. Shakuntala Thilsted presented the Nutrition Sensitive Approach in aquaculture and fisheries and highlighted the importance of fish for nutrition .Then, Mr. Chin Da presented our approach to Nutrition sensitive Aquaculture: the interventions and technical dimension of aquaculture using Small Indigenous Species (SIS). The workshop continued with a presentation by Dr. Olivier Joffre on the project's results. His presentation was followed by a Vissot representative presentation regarding fish powder and the use of fish in Ready to Use Therapeutic Food (RUTF).

The discussion in plenary covered technical aspects regarding SIS culture and the processing aspect. Regarding the technical aspects, the discussion highlighted the importance to adapt technology to the local environment and using locally available resources.

The discussion also explored the scaling of the technology and the development of the new product. Dr. Shakuntala highlighted the fact that using fish in nutrition sensitive approach is new and it requires more preliminary work to identify what works. Also, testing a new product takes time.

Additionally, WorldFish organized a study tour for 4 researchers of the Central Institute of Fisheries Technology from India (Indian Council of Agricultural Research, Ministry of Agriculture and Farmers Welfare, Govt. of India) on 22nd to 26th October 2018. The visit of the delegation aimed at presenting different approach to rice field fisheries enhancement and nutrition sensitive approaches to aquaculture and fisheries. The tour included visit of households supported by this project.

*Photo: Participants of the international workshop on Small fish for nutrition, held in Phnom Penh on the 3rd of December 2019*

After the workshop a field visit was organized on the 4th of December in Siem Reap province for international visitors from Africa and India. Invited participants from African countries will be involved in the up-coming EU-IFAD project in Malawi, Ghana and Cotes d'Ivoire. Participants from Assam State (India) are involved in a USAID funded project that will follow a similar approach with nutrient rich fish.

The visit included a visit of IFAD Funded project beneficiaries with:

- Fish-SIS –vegetable producers (2)
- Cooking and feeding demonstration

In the afternoon, the participants visited a Community Fish Refuge site (CFR), a USAID funded project implemented by WorldFish. This project follows a nutrition sensitive approach and operates within the same communities as the IFAD-EC funded project. This project builds community capacity to enhance rice field fisheries and provide training on nutrition. Detailed outcomes and learning from this field visit are found in a separate report.

*Photo: Group photo of all international visitors, WorldFish staff, partner NGO staff and local community members at the Trapeang Kuy CFR*

As part of the preparation of the next phase, WorldFish organized a regional expert workshop, with participants from Bangladesh, Cambodia, and Myanmar, to share existing knowledge on SIS domestication and discuss suitable research protocol for on-farm experiments of SIS breeding in Cambodia, where the SIS research is less advanced. The expert workshop and field trip also included a participant from JIRCAS, who has conducted research on SIS in Lao PDR since 2007. During the field trip, the participants visited 2 CFRs, 1 government hatchery, 4 SIS farms, 2 SIS fishing areas, 3 SIS fish powder producer households (interviews/FGDs with approximately 20 stakeholders). The interviews/discussions were conducted according to the guiding questions identified in advance of the field trip. The SIS species of interest were *Rasbora, Esomus, Amblypharyngodon* species that were used in the EU/IFAD project in Cambodia.

The objectives of the field trip were twofold:

- To share existing knowledge on SIS breeding and domestication in Cambodia, Bangladesh, Lao PDR, and Myanmar.
- To identify research priorities and discuss suitable research protocol for on-farm experiments of SIS breeding and culture in Cambodia, where the SIS research is less advanced.

Detailed outcomes and learning from this field visit are found in a separate report.

In addition WorldFish organized the visit of a delegation of Odisha Government (India) in Cambodia to learn from our nutrition sensitive approaches (https://www.worldfishcenter.org/events/official-visit-delegates-government-odisha?fbclid=IwAR3OgCNw0ClKpMkpwhhkW5TiNd4YQtXnuGzQUFO0u50btKda5ps4y-YCJj0).

## 3.3 ACTIVITIES PLANNED FOR 2020

In 2020, WorldFish will be engaging a consulting firm, *Emerging Market Cambodia,* to assess the market demand for SIS and ready-to-eat supplement based on fish. The results of this survey will be discussed in a separate report for year 2020.

## 3.4 VISIBILITY AND COMMUNICATION PLAN

In 2019, the project produced 2 short video for Social media coverage, targeting international audience. Those video were shared and posted on WorldFish LinkedIn account, Facebook account as well as on the EU-Delegation in Cambodia.

The videos are titled:

1. Small fish, big benefits for Cambodia's rural communities (Access: http://bit.ly/2KYY8sg)
2. Nutrition education for a brighter future in Cambodia (Access: http://bit.ly/2PoAUKq)

# 4 ZAMBIA COMPONENT

## 4.1 BACKGROUND

The IFAD-EC pilot program, conducted in partnership with the Department of Fisheries (DoF), aims to assess the impact of pond polyculture on household fish consumption in Luwingu District. 20 households were selected to practice pond polyculture through snowball sampling. All 20 households participated in trainings, after which 20 ponds were stocked with four/five different fish species (*Oreochromis macrochir, Tilapia rendalli, Tilapia sparrmanii, Barbus sp, Pseudocrenilabrus philander*). A baseline survey was conducted in September, focusing on nutrition and food security indicators. The end line survey is scheduled to take place March 2020. Longitudinal fish consumption data will be collected for six months to assess estimated fish consumption, data will be collected from the pond polyculture group along with two control groups (agriculture n=20, aquaculture (monoculture) n=17). Pond production data is scheduled to be collected during stocking in March 2020.

The goals of the program was to increase availability, access and consumption of micronutrient rich small fish to improve household nutrition in targeted population groups. The specific objectives were:

- To expand pond polyculture to 20 aquaculture households in Luwingu district
- To collect fish consumption data on three different household groups
    - Pond polyculture
    - Aquaculture (monoculture)
    - Non-aquaculture/agriculture (monoculture)

13 wards were visited to scope the progress on the previous components of the project. A fish farmer from each community was identified through the DoF and instructed by WorldFish staff to gather all fish farmers within the community for a meeting. After the initial assessment of the previous components of the project, farmers (n=10) in Nsombo, the site of the initial pilot program, reported that they sold the fish stocked during the project, with all ten ponds remaining un-stocked and therefore, new communities were selected to relaunch the project. 20 farmers that met the pre-defined selection criteria were enrolled with plans to begin a new component in July 2019.

## 4.2 ACTIVITIES UNDERTAKEN IN 2019

### 4.2.1 Nutrition Education Training

Over a six-day period (22nd July to 31st) in July 2019, 33 farmers were trained in pond polyculture (PP), gender and nutrition in Luena and Mwingilila villages. The trainings were conducted in partnership with the DOF, a facilitator from World Vision and Peace Corps volunteers. All 15 participants in Mwingilila were female, chosen specifically to ensure a safe space for women to engage in training materials, while a mixed gender group was chosen for

Luena. With the same gender breakdown, ten from each group were selected using snow ball sampling to participate in the project (n=20). The trainings were open to the participants selected for the PP pilot program along with fish farmers from the community. The main topics covered in the trainings included, PP technology, pond management, feed formulation, nutrition and gender.

On 22nd and 29th July respectively, farmers in both villages were trained on the benefits of PP production systems, their advantages and disadvantages, factors affecting fish growth, farm management practices such as integration, common fish diseases and their prevention. The famers were also encouraged to discuss gender roles in aquaculture in their respective communities. Facilitators discussed how aquaculture and more specifically PP could be beneficial to gender equity and equality within the household.

On 23rd and 30th July respectively, the focus of the day was stocking, feed and feed formulation facilitated by DoF along with a farmer trained by WorldFish. Two Peace Corps volunteers also participated in the workshops applying their knowledge of the local communities, the available ingredients and previous trainings held of feed formulation. The topics of discussion included effective fish handling techniques, fish nutrition, feeding habits and the Pearson Square method. After which the participants were separated into two groups and took part in a feed formulation workshops using local ingredients.

On 29th and 31st July, topics included harvesting, human nutrition, gender and sustainability facilitated by WorldFish staff, DOF and a facilitator from World Vision. Farmers in both villages were trained on partial harvesting for household consumption, nutritional benefits of SIS consumption with a focus on the first 1000 most critical days, sustainable fishing practices. During the last day of the trainings a special emphasis was put on sustainability and self-reliance. Gender and nutrition discussion also took place involving an open discussion on the difference between gender roles and sex roles and how these concepts influence household nutrition.

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**Stocking**

Over the course of three weeks (5th August – 23rd August), 20 ponds were stocked with four to five species each (*Oreochromis macrochir, Tilapia rendalli, Tilapia sparrmanii, Barbus sp.,*



*Figure 1: DoF staff present at trainings, Mwingilila* *Figure 2: Feed formulation workshop, Mwingilila*

*Pseudocrenilabrus philander*). Stocking was completed in partnership with the Department of Fisheries (DoF), local breeders and Peace Corps volunteers. An extra DoF officer was outsourced from the neighbouring district due to his extensive experience working with the WorldFish team stationed in Kasama and in stocking ponds in the Northern Province. Sourcing and collecting fish took place between 1am and 6am and transportation and stocking had to be completed before 12pm. These times were chosen due to weather patterns, as extreme heat can increase the risk of mortality.

*Table 1: list of species stocked for pond polyculture pilot project*

| **Species** | **Quantity per pond** |
|---|---|
| *Oreochromis macrochir* | 400 |
| *Tilapia rendalli* | 200 (2 ponds only) |
| *Tilapia sparrmanii* | 100 |
| *Barbus sp.* | 50 |
| *Pseudocrenilabrus philander* | 100 |

*Figure 3: Participant stocking pond.*

*Figure 4: Juliet Ndbala transport fish to her pond*

*Figure 5: Farmers participate in stocking training*

Mortalities were expected due to terrain and transportation, therefore, for each species an extra 10% was added to mitigate the calculated expected loss of fish. During the planning stages we mitigated and accounted for various factors that could impact mortality including transportation (fish was checked every 30 minutes during transportation), conditioning and handling techniques (handling was discussed with each breeder and fisherman). Farmers reported high mortality rates in the days after each fish species was stocked however, after sampling each pond, we confirmed that morality rates remained low and the fish began reproducing within one month.

Initially *T. rendalli* was to be stocked in all 20 ponds, however, after arriving to collect the fish species for distribution from the breeder we discovered high rates of mortality. We had planned to source 4000 *T. rendalli* from a breeder in Nsombo, however, only 200 survived and therefore, only two ponds were stocked, both of which were randomly selected. During this period alternative solutions were suggested, including sourcing from Lake Bangeweulu, yet the fisherman hired to catch and select fish for distribution from the wild were unable to catch the amount of *T. rendalli* needed with such short notice. Due to this unforeseen circumstance, we concluded that each pond would be stocked with four species only (*Oreochromis macrochir, Tilapia sparrmanii, Barbus sp., Pseudocrenilabrus philande*r). With the exception of *Oreochromis macrochir*, which was sourced from one breeder, all other species were sourced from Lake Bangeweulu. *T. sparrmanii* was intended to be collected from a breeder in Nsombo, however, due to high mortality rates, the remaining needed was sourced from Lake Bangeweulu.

### 4.2.2 Sampling

In order to assess pond production each pond was sampled within the first month of stocking. Initially fish was weighed during stocking, however, high mortality rates occurred prior to transporting the fish and therefore, fish was weighed prior to stocking in the wild and within the breeder's ponds. Consequently, one month after stocking, when the risk of mortalities reduced, the total length and weight of 10% of every species stocked was measured. Over the course of ten days (10$^{th}$ September – 20$^{th}$ September) in partnership with DoF, each pond was netted and sampled.

During sampling it was discovered the majority of ponds contained various other species due to bycatch including, *T. rendalii, Serranochromis robustus,* and *Marcusenius macrolepidotus*. The total length and weight were measured for all species including *T.* rendalii which was stocked in two ponds. The mean weight and length, 11.18g and 7.67cm respectively, were similar to the average weight for both ponds (Table 2). Two ponds were found not to contain any SIS, one such pond did not have screens on either the inlet or outlet, with fish being found outside of the pond in the water source and a neighbour's pond. Despite netting the second pond several times only one *P. philander* was identified, with the farmer reporting high rates of SIS mortality post stocking. The mean total length and weight of SIS (67% *P. philander*, 33% *Barbus sp.*) across 20 ponds were 4.15cm and 1.84g respectively (Table 2). However, *Barbus sp.* weighed considerably less than *P. philander*, with a mean total weight of 1g. *O. macrochir* was sourced exclusively from breeders within Luwingu district, however, due to the high numbers needed, the fingerlings varied greatly in size. The lowest mean weight was 5.78g in

comparison to the highest at 24.25g, with the mean being 13.37g. *T.* sparmanii was sourced from a breeder in Nsombo along with Lake Bangeweulu, across 20 ponds the mean total weight and length were 5.04g and 5.92cm respectively (Table 2).

*Figure 7: WorldFish, DoF and Judith Chola (farmer) weigh and measure fish during sampling*

*Figure 8: WorldFish and DoF staff measure fish during stocking*

*Table 2: Sampling information (mean total weight and length, pond size) for pond polyculture pilot project ponds*

| | | ***O. macrochir*** | | ***T. sparmanii*** | | ***T. rendalii*** | | **SIS (*Barbus sp.* 33%, *P. philander* 67%)** | |
|---|---|---|---|---|---|---|---|---|---|
| **ID** | **Pond size (m²)** | **Length (cm)** | **Weight (g)** | **Length (cm)** | **Weight (g)** | **Length (cm)** | **Weight (g)** | **Length (cm)** | **Weight (g)** |
| **1** | 200 | 8.6 | 12.18 | 5.91 | 4.4 | - | - | 4.15 | 1.93 |
| **2** | 238 | 10.09 | 20.13 | 5.42 | 3.8 | - | - | 4.17 | 1.27 |
| **3** | 520 | 8.44 | 13.5 | 6.06 | 5.3 | - | - | - | - |
| **4** | 234 | 7.78 | 10.25 | 5.93 | 4.8 | - | - | 4.02 | 2.27 |
| **5** | 171 | 7.38 | 8 | 5.14 | 4.5 | - | - | 4.58 | 2 |
| **6** | 162 | 7.61 | 10.75 | 5.65 | 4.3 | - | - | - | - |
| **7** | 330 | 6.38 | 5.78 | 5.23 | 4.35 | - | - | 4.09 | 1.4 |
| **8** | 160 | 8.8 | 13.85 | 4.61 | 3.3 | - | - | 4.41 | 2.2 |
| **9** | 360 | 8.16 | 11.8 | 5.71 | 5.3 | - | - | 3.98 | 2 |
| **10** | 500 | 7.38 | 9.68 | 6.05 | 6 | - | - | 2.16 | 1.13 |
| **11** | 379.5 | 8.09 | 11.75 | 6.56 | 6.9 | - | - | 4.28 | 1.9 |
| **12** | 252 | 9.74 | 19.08 | 6.07 | 4.9 | - | - | 4.24 | 1.67 |
| **13** | 180 | 9.54 | 18.33 | 6.98 | 7.1 | - | - | 4.17 | 1.53 |
| **14** | 200 | 8.35 | 12.23 | 6.97 | 5.8 | - | - | 4.44 | 1.79 |
| **15** | 242 | 8.81 | 14.93 | 5.99 | 4.8 | 7.43 | 10.3 | 4.11 | 1.27 |
| **16** | 189 | 9.99 | 24.25 | 6.21 | 6.5 | - | - | 3.7 | 1.2 |
| **17** | 270 | 7.81 | 9.38 | 5.98 | 4.88 | 7.91 | 12.05 | 4.11 | 1 |
| **18** | 234 | 9.51 | 16.58 | 5.35 | 3.91 | - | - | 4.47 | 2.1 |
| **19** | 311.4 | 9.43 | 16.4 | 6.59 | 5.2 | - | - | 6.16 | 4.82 |
| **20** | 76.5 | 7.37 | 8.48 | 6.02 | 4.83 | - | - | 3.47 | 1.7 |
| **Mean** | **260.47** | **8.46** | **13.37** | **5.92** | **5.04** | **7.67** | **11.18** | **4.15** | **1.84** |

### 4.2.3 Baseline

From 9th September – 20th September WorldFish staff in partnership with DoF conducted a baseline survey, sampled ponds and trained participants on M&E protocols. During this time two control groups were also identified through snowball sampling methods. 20 agriculture (AG) farmers were selected within Luena and Mwingilila, the same villages were the pond polyculture (PP) group resides. A household was randomly selected after which they were asked to identify farming households, the pattern continued with each farmer identified, a total of 20 farmers consented to participate in the project. The same process occurred when selecting aquaculture (AQ) farmers, of which we specifically targeted farmers rearing only one fish species. A total of 17 farmers consented to participate in the project, located in Fisonge and Saili villages. All 57 farmers were interviewed for the baseline survey and trained on M&E protocols, which they needed to begin to fill out monthly for six months. The PP group in comparison to the control groups had three protocols to complete each month, fish consumption, harvesting and one focusing on pond management. Oppositely, the control groups were trained on and instructed to complete the fish consumption protocol only. The baseline survey focused on nutrition and food security indicators including dietary diversity scores (DDS), household food insecurity access scales (HFIASC) and a food frequency questionnaire (FFQ) focusing on fish consumption, complied after analysing frequently consumed fish species in Luwingu District from a previous WorldFish baseline dataset. The food intake (DDS) of the farmers were collected by individual 24-hour recalls by a trained individual (WorldFish staff) on a random day to minimize day to day differences. Dietary diversity was defined by 12 food groups relevant to the Zambian diet totaling to a score of 12. The PP group had the lowest mean DDS (5.2/12) with both the PP and AG group scoring within the lower quartiles yet still in the middle range (3-6) (Table 3). The AQ group scored the highest for DDS and the lowest for the HFIASC.

*Table 3: Partially analyzed baseline dietary diversity and food security scores*

| Group | Mean Dietary Diversity Score (DDS) | Mean Household Food Insecurity Access Scale (HFIASC) |
|---|---|---|
| Pond Polyculture | 5.2 | 10.7 |
| Aquaculture | 6.29 | 9.65 |
| Agriculture | 5.45 | 11.8 |

*Table 4: Fish species most frequently consumed across 57 households*

| Species | Never or less than once a month | 1-3 times a month | 4-5 times a month | once a week | 2-4 times a week | 5-6 times a week | once a day | More than once a day |
|---|---|---|---|---|---|---|---|---|
| ***O. macrochir*** | 75.44% | 15.79% | 5.26% | 0% | 3.51% | 0% | 0% | 0% |
| ***T. sparmanii*** | 21.05% | 29.82% | 14.04% | 3.51% | 28.07% | 1.75% | 0% | 1.75% |
| ***P. philander*** | 24.56% | 29.82% | 14.04% | 1.75% | 17.54% | 7.02% | 3.51% | 1.75% |
| ***Barbus sp.*** | 50.88% | 22.81% | 5.26% | 3.51% | 7.02% | 3.51% | 3.51% | 3.51% |
| ***T. rendalii*** | 50.88% | 29.82% | 3.51% | 1.75% | 26.32% | 0% | 0% | 5.26% |
| ***Marcusenius macrolepidotus*** | 45.61% | 1.75% | 5.26% | 3.51% | 7.02% | 1.75% | 1.75% | 1.75% |
| **Catfish** | 36.84% | 22.81% | 15.79% | 7.02% | 7.02% | 3.51% | 3.51% | 3.51% |
| **Large mouth** | 50.88% | 28.07% | 5.26% | 0% | 5.26% | 3.51% | 3.51% | 3.51% |
| **Brown bream** | 70.18% | 21.05% | 3.51% | 0% | 1.75% | 1.75% | 1.75% | 0% |
| ***Potamothrissa acutirosis*** | 36.84% | 29.82% | 10.53% | 3.51% | 7.02% | 1.75% | 5.26% | 5.26% |

Partially analysed data from the FFQ showed that very few farmers consumed fish more than once a day however, *T. rendalii* and *Potamothrissa acutirosis* were consumed more than once a day in >5% of farmers, all of which reside in Luena. Both species are commonly eaten and easily accessible in this location due to the Luena River. Both fish species along with *T. sparmanii* are the most commonly consumed fish in Luena and Mwingilila combined due to their proximity to the river. Fish consumption data will be collected from all three groups over the course of six months.

### 4.2.4 M&E visits

M&E visits commenced in October 2019 and will end in March 2020 upon the completion of the project. All 57 participants were trained on protocols in September during the baseline survey. Each month protocols will be collected and re-distributed, with the data from each month contributing to relevant datasets (fish consumption and pond polyculture). These activities will take place until March 2020, where similar to September, WorldFish staff in partnership with DoF, will sample all 20 (biomass) ponds and an end-line survey will be conducted to commence the project. The major outputs of this project will be datasets that can be used to contribute to the evidence base on the role of pond polyculture on fish consumption and nutrition.

### 4.2.5 Reports and publications

No publications have been produced during this reporting period due to field activities and the pilot program commencing May 2019. However, the main outputs of this project will be datasets that can contribute to relevant reports and publications.

### 4.2.6 Problems

Initially, fish was distributed in 2017 to ten households in Nsombo village. However, upon our arrival in Luwingu District we found that the farmers had sold and distributed their fish to fellow farmers and local business men. Therefore, another location and sample were selected during scoping visits to all 13 wards within the district. Both the sample and location were chosen based on a pre-defined selection criterion.

### 4.2.7 Collaborators

For the duration of this reporting period, the team stationed in Luwingu partnered with DoF. CSO-SUN (Civil Society Organizations – Scaling up Nutrition) will partner with WorldFish staff on policy briefs focusing on SIS, pond polyculture and nutrition and on holding a stakeholder workshop to commence the project.

### 4.2.8 Future plans

With the remaining three months of the project the future activities include:

- M&E visits
- Draft policy briefs developed on:
    - The role of SIS on the first most critical 1000 days
    - The role of pond polyculture on fish consumption and food security
- Stakeholder workshop/dissemination meeting
    - Stakeholder workshop in Zambia to review the implementation and future scale up of the project
    - Small workshop and scoping activities in Lilongwe, Malawi, to discuss scale up activities with partners and donors in Malawi
- End-line survey
- Final sampling
    - Weigh biomass of each pond

# 5 INDONESIA COMPONENT

In 2019, WorldFish continued with the joint efforts with the Ministry of Marine Affairs and Fisheries, (MMAF), Indonesia, to refine the three policy briefs focusing on nutrition-sensitive fish food systems that were drafted earlier. These policy briefs were developed with the following subject:

1. Nourishing with Small Fish in the First 1,000 Days of Life in Lampung Province, Indonesia

2. Small Fish Processing, Education, and Social Behaviour Change for Fish Consumption to Support the First 1000 Days of Life in Indonesia

3. Sustainable Production of Small Fish to Support Micronutrient Supply for the First 1,000 Days of Life in Indonesia.

These briefs will be used for influencing fish production systems, for example, use of reservoirs to produce nutritious fish and collaboration with the Ministry of Health for the use of fish and fish products for pregnant and lactating women and young children. They also look towards synergizing various governmental efforts and campaigns to address malnutrition issues in Indonesia.

A workshop is planned for 2020 to engage various stakeholders, including the government departments, policy implementers, research institutions, private sector, and international and local non-governmental organizations to discuss, review, refine and adopt these policies for implementation.

# ANNEX A: SMALL FISH FOR NUTRITION WORKSHOP REPORT

## 1. INTRODUCTION

The European Union and IFAD-funded *Managing Aquatic Agricultural Systems to Improve Nutrition and Livelihoods* project ("*Small Fish for Nutrition*" for short) uses an integrated aquaculture and agriculture-nutrition linkages approach to support poor, rural households in wetlands systems in Cambodia to improve production and productivity of small indigeneous species of fish in household aquaculture ponds, and increase consumption of micronutrient rich small fish and vegetables.

The project is a component of the global project being implemented in Myanmar, Zambia and Cambodia. It buids on the sucesses and lessons learnt from WordlFish project *Linking Fisheries and Nutrition:promiting Innovative Fish Production Technologies in Ponds and Wetlands with Nutrient-Rich Small Fish Species in Bangladesh* (2010-2013), which developed the Aquaculture/Agriculture-Nutrition Linkages approach.

*Small Fish for Nutrition* scaled up the integrated Aquaculture/Agriculture-Nutrition Linkages approach in over 300 households in Pusat, Battambang and Siem Reap. The goal of the project was to improve the nutrition and livelihood of poor rural households in aquuatic agricultural sysems in the selected provinces of Cambodia through increasing micronutrient-rich small fish and vegetable intake by self-production, as well as through increased household income.

The main component of the project are as follows: i) develop integrated Aquaculture/Agriculture Intervention Models; ii) improve productivity and production of integrated household Aquaculture/Agriculture systems; iii) promote increased practice of esssential nutrition and hygiene actions.

The projet was implemented during two years in three provinces around the Tonle Sap lake, with three NGO partners and with support from the Fisheries Administration, Cambodia. The objectives of the final workshop were: i) present the main findings and outcomes of the project; ii) receive feedback from the audience; iii) identifiy lessons learnt and entry points to support scaling of the technology; iv) share the approach with international partcipants from Africa and India who will implement similar approach in the future.

The final workshop included three components: a plenary session - to present findings, followed by a multi-stakehodler participatory workshop to identify recommendations on the 3rd December 2019. Finally on the 4th of December a study tour to different project sites in Siem Reap province was organised for international participants

## 2. WORKSHOP

### 2.1. Plenary session

The workshop was held in Phnom Penh on the 3rd of December 2019, with presentations in a plenary session from Dr. Shakuntala Thilsted (WorldFish), Mr. Chin Da (vice director of the Department of Aquaculture Development (DAD), Fisheries Administration), Olivier Joffre (WorldFish) and Mr. Lyndon Paul, from Vissot, a social enterprise developing Ready to Use Therapeutic Food (RUTF).

Sixty eight participants included: 14 NGO representative, 4 donors and development agencies (USAID, JICA, GIZ and WFP), 7 students and representatives of universities and 8 government representatives from MAFF and Fisheries Administration, 3 private sector representatives, as well as 9 WorldFish staff and 15 farmers (see Annex B for the list of participants). We also had a delegation from Africa composed of representative of WorldFish Malawi, Lilongwe University of Agriculture and Natural Resources in Malawi; CSIR Water Research Institute from Ghana; IITA in Kenya, Africa Rice in Cotes D'Ivoire and private sector from Ghana, as well as three representatives from Assam State in India, where WorldFish will deploy a similar approach.

After the opening remarks from the Vice Director of the Department of Aquaculture Development (DAD), Fisheries Administration, Dr. Shakuntala Thilsted presented the Nutrition Sensitive Approach in aquaculture and fisheries and highlighted the importance of fish for nutrition (see Annex C).

Then, Mr. Chin Da presented our approach to Nutrition sensitive Aquaculture: the interventions and technical dimension of aquaculture using Small Indigenous Species (SIS). The workshop continued with a presentation by Dr. Olivier Joffre on the project's results. His presentation was followed by a Vissot representative presentation regarding fish powder and the use of fish in RUTF.

The discussion in plenary covered technical aspects regarding SIS culture and the processing aspect. Regarding the technical aspects, the discussion highlighted the importance to adapt technology to the local environment and using locally available resources.

The discussion also explored the scaling of the technology and the development of the new product. Dr. Shakuntala highlighted the fact that using fish in nutrition sensitive approach is new and it requires more preliminary work to identify what works. Also, testing a new product takes time.


Mr. Chin Da, Deputy Director Department of Aquaculture Development Fisheries, presents at plenary session


Dr. Shakuntala Thilsted, Research Program Leader for Value Chains and Nutrition at WorldFish, presents at plenary session

The discussion emphasized the need to work with partners outside of agriculture and engage NARES and department working on health and nutrition at the start of the project. Multi-dimensional approaches are required, even though it is important to invest in research to improve the productivity of both vegetable and fish production, it is equally important to assess the legal framework when developing the product and also look at the acceptability of the product by target groups. Finally, the participant discussed the role of women in those approaches and the importance of taking into consideration the additional work load for women.

Yumiko Kura, WorldFish country director, gave closing remarks highlighting: i) the importance fish have to play globally for food and nutrition security; ii) the need for research to enhance productivity and efficiency of those systems; iv) the need to work with locally available resources iii) the knowledge gaps regarding the market demand for SIS and processed products and finally the importance in involving the private sector and supporting to facilitate scaling of technology and products.

### 2.2. Lesson learn and recommendations from stakeholders

The afternoon session involved 27 stakeholders from 4 main groups: 4 Fisheries Administration Cantonment Officers; 15 farmers (beneficiaries of the project) and hatcheries operators, 8 NGO partners.

The participants were divided into 4 mixed groups and explored three themes:

- What are the five main constraints to continuing this nutrition sensitive production system after the closure of the project? And what are the potential solutions
- How to get access to quality fingerlings (commercial fish) and enough SIS?
- What are the key recommendations for the following thematic:
    - Access and handling of fingerlings
    - Pond management and feeding
    - Harvesting, preparing, consuming and marketing fish
    - Vegetable production
    - Rice field pond system

Figure 1: Multi-stakeholders group session discussing the three themes and reporting in plenary

Each group provided the five main constraints. The table below summarizes the main constraints (most frequently cited) and potential solutions expressed by the different groups.

Table 1: Constraints and solutions to continuing nutrition sensitive aquaculture system

| **Constraints** | **Solutions** |
|---|---|
| Some cultured fish species are not accepted in the rural market | • Provide a technical training course on fish seed and brood stock management<br>• Study the market demands |
| Lack of fingerling and fish brood stock suppliers | • Look for donors and projects to support the seed purification station<br>• Work out with technical institutions and stakeholders to establish the fish hatchery with proper brood stock management |
| Long distance to transport the fingerlings and some road conditions are terrible | • Establish the hatchery station locally to supply good quality fingerlings |
| The price of small fish (SIS) is high | • Keep the brood fish available locally<br>• Establish the hatchery for producing both small and big fish fingerlings<br>• Set up the local group of fingerling producers<br>• Provide the technical training course on brood stock management and fingerling production |
| The time of fingerling stocking is not suitable with the local situation – fingerlings are not available when the water level is suitable in the pond | • Ensure brood fish is available locally<br>• Work out with technical institutions and stakeholders to establish the fish hatchery with proper brood stock management |
| Lack of technical aspect: pond preparation, difficult to improve water quality (water color turned to too brown, too green and gray) | • Follow the technical instructions including a pump out the water and dry out the pond, remove the predators, apply the lime and organic fertilizer |
| The quality of fish powder processing is not reliable | • Provide more technical training on fish powder processing |
| Some farmers do not follow the technical guideline (there are some predators in the pond) | • Dry out the pond and clean the pond properly by applying lime |
| The quality of vegetable seed is low (low rate germination) | • Select vegetable seeds from well-known companies.<br>• Pay attention to the expired date which on stated on the packet |

The consultation highlighted different constraints related to production at the pond or plot level. Access to fingerlings and the quality of the latter is a common issue, not only related to nutrition sensitive aquaculture but to the overall aquaculture sector. Access to SIS to stock in the pond is an issue and requires a specific organization to keep brood fish in the pond across the

season. Participants also explored a solution to access both fingerlings and SIS after the closure of the project and they highlighted the following key points to explore further

- Identify reliable fingerlings suppliers who provide high quality fingerlings
- Establish the hatchery for producing both small and big fish fingerlings (potentially government managed at the provincial level)
- Keep SIS brood fish in ponds across the seasons if possible, with an SIS reservoir in a specific pond
- Stocking the same size of fingerling and healthy fingerlings
- Set up a group of fish farmers to buy the fingerlings at the same time
- Improve transportation tools and techniques, especially for SIS

The species assemblage needs to reflect the market demand, as well as the ecological complementarity. Understanding the market and promoting products on the local market is also important to sustain fish powder processing activities.

Finally the recommendations to sustain such approach and scale it in the Cambodian context are:

**Access and handling of fingerlings**

- Fish farmers have to understand the local market demand and adjust the species assemblage
- Fish farmers have to collaborate with FiA and key stakeholders (NGOs and hatcheries) are located a long distance from fish farmers, hindering an efficient technical support
- Fish farmers have to follow the technical guideline properly
- Fish farming (stocking, harvesting) have to be planned properly, according to season and water and fingerlings availability

**Pond management and feeding**

- Awareness raising and dissemination the benefit of fish raising to farmers, including small fish;
- Pay high attention to the site selection for fish farms (closed to water sources, not far from connection road, market and hatchery station)
- Provide more capacity building and training to fish farmers particularly on pond preparation and water management and fish feeding
- The technical training on integrated fish farming needs to be provided using simple training materials
- Improving the water quality through water filters or/and water treatment

**Harvesting, preparing, consuming and marketing fish**

- Should introduce the safe fishing harvesting tools and techniques for both small fish and big fish, reducing the stress of fish during the harvesting period
- Farmers should understand the fish market demands before stocking fingerlings
- Fish powder producers should improve the quality of processing and packaging to attract consumers
- Should set up and improve the collaboration among key stakeholders to disseminate the benefits of small fish
- Should have technology and regulation to avoid drying-out the pond for fish harvesting, in order to adapt with climate change condition

**Vegetable production**

- Feasibility study, at the farm level, on available resources and capital to improve vegetable production
- Should grow the vegetables which are grown fast
- Provide technical guidelines before receiving/purchasing input to farmers (soil and bed seeding preparation). It will give more time to farmers to assess the labour requirements and give more time to prepare the crop
- Labor and responsibilities for vegetable garden need to be arranged properly within the household
- Should apply the compost (organic fertilizers) and natural pesticide

**Rice Field pond system**

- Rice field ponds need to be set up closed to water sources
- Need to understand the fish feeding behaviors
- Pond preparation needs to follow technical guidelines
- Closely monitor the water quality in the fish pond
- Set up the hatchery station locally to facilitate access to fingerlings

## 3. FIELD VISIT

### 3.1. Participants, activities

A field visit was organized on the 4th of December in Siem Reap province for international visitors from Africa and India. Invited participants from African countries will be involved in the up-coming EU-IFAD project in Malawi, Ghana and Cotes d'Ivoire. Participants from Assam State (India) are involved in a USAID funded project that will follow a similar approach with nutrient rich fish.

The visit included a visit of IFAD Funded project beneficiaries with:

- Fish-SIS –vegetable producers (2)
- Cooking and feeding demonstration

In the afternoon, the participants visited a Community Fish Refuge site (CFR), a USAID funded project implemented by WorldFish. This project follows a nutrition sensitive approach and operates within the same communities as the IFAD-EC funded project. This project builds community capacity to enhance rice field fisheries and provide training on nutrition.

Beneficiary from an IFAD/EU funded explaining his vegetable production

International visitors listen in on a caregiver session at an IFAD/EU funded project site

Group photo of all international visitors, WorldFish staff, partner NGO staff and local community members at the Trapeang Kuy CFR

### 3.2. Feedback and learning

After the filed visit the international participants reflected on the workshop and the visit. Reflections of the different participants are summarized below:

*About the study tour*

The field trip helped to clarify how those system works as they can sound like complex systems.

*About the approach*

- Generating income is important for scaling this approach to Africa;
- Partnership with rice specialist like IRRI (in Asia) or AfricaRice (in Africa) is important because fish-rice culture should consider both rice and fish and not focus only on fish;
- The CFR approach to managing fisheries is an interesting approach. It shows that the community can successfully engage in managing their natural resources. It could be applied in Zambia were the capacity of the government and communities to enforce the fishing ban is low. The approach to build community capacity to enforce fishing ban could be transferred to Zambia. A similar approach to community based resources management could be applied for “beel” fisheries in India;
- Public-private partnership is required to make the intervention sustainable. The example of Vissot is interesting as it includes government and international organizations. Nutrifix’s model can be applied in India.

*Nutrition dimension*

- The approach needs to be contextualized to the different contexts in Africa, but it is scalable in Africa and nutritional benefits should be the entry point. Transferring and scaling this approach using the nutritional approach is key to success.
- In Africa, tilapia and catfish are central to aquaculture development but we have small fish that are now used only to feed the commercial fish. In Africa small fish often come from the sea and are fermented for taste, but not for its nutritional value. In Cotes d’Ivoire fish consumption per capita is high. Transferring the technology in Cotes d’Ivoire will require effort as aquaculture is based on catfish not SIS. In Malawi it will be easier as SIS are available. Fish powder can be easily integrated into porridge in Malawi.
- Changing the behavior of mothers to incorporate fish into children's diets is difficult. Demonstration as done in this project can be applied, together with additional sessions on nutrition education, in Africa to convince mothers.
- The demonstration of processing and preparation of the fish is a useful way to explain the simplicity of the method. It also shows that you can add the ingredient to make it more palatable and it is a flexible recipe with different ingredients.
- We are lacking a powerful message to incorporate fish into nutrition and trigger the interest of the private sector
- We should take care of the feedback mechanism. Promoting SIS creates a new demand within wealthier households and increase SIS price.

*Research needed*

- Need to look beyond input and production systems and there is a need to put greater emphasis on post-harvest and processing
- Acceptance of fish powder can be an issue in Malawi. Research on acceptability and product design to produce a fish based product that responds to nutritional needs and the taste of consumers is required. In Malawi bitterness of the fish powder was a reason for non-acceptance. Research on process, acceptance and product design is required. Consumer research and understanding of the demand.
- Research should first look at the nutrient requirement first and which combination of vegetable-fish is best suited for a better diet and respond to nutritional gap;
- The technical aspect is important for introducing the system to Africa: research should work on the efficiency of feeding and fertilization of the system as well on the integration of fish and vegetable culture;

*Scaling to India:*

SIS are available, production systems are based on carps but what is required is to raise awareness and educate communities on nutrition and the importance to improve diets. The method applied in Cambodia is interesting. In India, proteins come mostly from pulses, but SIS should be promoted as a source of micro-nutrient.

Within the ASSAM project, we need to:

- Domesticate the SIS – now only capture from the wild;
- The community needs to be educated and recipe to integrate SIS and vegetable for improved diet need to be developed;
- SIS can be promoted as complementary to large commercial fish, to improve nutrition
- A landscape approach to conservation of habitat for the SIS in the “beel”, as well as the rice field fisheries model;
- Not ignore the small ponds to be more inclusive of smallholders.