

Commercialization of Aquaculture for Sustainable Trade (CAST) Cambodia: Baseline Study Report

The *Commercialization of Aquaculture for Sustainable Trade (CAST), Cambodia*, project is funded by the United States Department of Agriculture (USDA) and implemented by the American Soybean Association (ASA) and World Initiative for Soy in Human Health (WISHH).

The project supports increased agricultural production and trade in Cambodian aquaculture.

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Commercialization of Aquaculture for Sustainable Trade (CAST) Cambodia

Baseline Study Report

Prepared for
American Soybean Association (ASA) and World Initiative for
Soy in Human Health (WISHH)

Prepared by
WorldFish

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Table of Contents

EXECUTIVE SUMMARY.....	1
1. INTRODUCTION	7
2. METHODOLOGY.....	8
2.1 Methods for population-based survey	8
2.1.1 Survey design and objectives	8
2.1.2. Respondents and study areas	9
2.1.3. Understanding the population of interest	11
2.1.4. Sample design	11
2.1.5. Questionnaire design.....	13
2.1.6. Field work.....	13
2.1.7. Quality control and data cleaning	15
2.1.8. Data analysis and indicators.....	15
2.1.9. Covariate and propensity score matching (PSM)	16
2.2. Methods for qualitative study	17
2.2.1. Objectives and topical focus area	17
2.2.2. Study participants, interviewing and data collection	18
2.2.3. Data preparation, coding and analysis.....	18
2.3. Limitation of the data collected	19
3. BASELINE RESEARCH QUESTIONS	20
3.1. What is the current productivity of feed mills, aquaculture producers and hatcheries and nurseries?	20
3.2. What is the current soy protein and fish product trade in Cambodia?	20
3.3. What is the current quantity and quality of feed and seed produced for aquaculture producers and its availability and accessibility?.....	21
3.4. What is the current supply of premium quality, Cambodian-grown freshwater fish to the local market?	22
3.5. What is the current potential beneficiaries' ability to access finance that is needed for business growth and development?.....	23
3.6. Where are clusters of active SME farms and hatcheries that meet the selection criteria as potential beneficiaries of CAST?	25
3.7. Where are existing value chain networks at provincial level that can be strengthened to meet CAST objectives?	25
3.8. Who and where are existing or potential extension service agents that can become core facilitators of value chain networks?.....	25
3.9. What are the constraints and opportunities within various segments of the commercial aquaculture value chain in Cambodia?.....	26
4. SITUATION ANALYSIS.....	26
4.1. Population characteristics	26

4.2.	Seasonality of production and sales	27
4.3.	Hatcheries and nurseries production systems	29
4.4.	Fish farm production systems	30
4.5.	Post-harvest (collectors, wholesalers and processors)	33
4.6.	Support system	35
4.6.1.	Access to loans	35
4.6.2.	Access to knowledge and information	36
4.7.	Aquaculture feed production and distribution.....	37
4.8.	Climate change adaptation	38
4.9.	Spatial distribution of farmer clusters and processing hubs	39
5.	STANDARD AND CUSTOM INDICATORS	41
5.1.	Infrastructure and assets	41
5.2.	Production and value of aquaculture products	43
5.3.	Management practices of producers and input suppliers.....	44
5.4.	Post-harvest related indicators	45
5.5.	Access to loans and information	47
6.	COVARIATE AND CONFOUNDER ANALYSIS AND PROPENSITY SCORE MATCHING	48
6.1.	Covariate analysis	48
6.2.	Confounder variables	50
6.3.	Propensity Score Matching (PSM) analysis	51
7.	QUALITATIVE STUDY.....	51
7.1.	Aquaculture industry	52
7.1.1.	Constraints and opportunities to development of commercial aquaculture sector	52
7.1.2.	Constraints and opportunities to developing a traceability and quality control system for aquaculture products	53
7.2.	Program implementation	53
7.2.1.	Barriers to program implementation	53
7.2.2.	Facilitators to program implementation	54
7.3.	Services and support needed for beneficiaries' success	55
7.4.	Relationship building	55
8.	KEY FINDINGS.....	57
8.1.	Aquaculture production and quality	57
8.2.	Value chain efficiency.....	59
9.	RECOMMENDATIONS	59
9.1.	Aquaculture production and quality	59
9.2.	Value Chain efficiency	61

9.3. Design of Monitoring and Evaluation system for CAST.....	62
10. CONCLUSION.....	63
REFERENCES	64
ANNEXES.....	64
ANNEX A: REQUEST FOR PROPOSALS (RFP) TO CONDUCT A BASELINE EVALUATION FOR ASA/WISHH'S FOOD FOR PROGRESS (FFPR) PROGRAM IN CAMBODIA	65
ANNEX B: SAMPLING FRAMEWORK	97
ANNEX C: QUESTIONNAIRES & SURVEY TOOLS.....	115
ANNEX D: STANDARD AND CUSTOM INDICATORS	215
ANNEX E: LIST OF KEY INFORMANTS	225
ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS.....	226
ANNEX G: COVARIATES ANALYSIS	242
ANNEX I: QUALITATIVE STUDY FINDINGS	268

List of Figures

Figure 1: Treatment (green) and control (blue) provinces of CAST program	10
Figure 2: Yield of cage (left) and pond-based (right) aquaculture systems in treatment and control provinces	20
Figure 3: Relative volume of fingerlings species sold by hatcheries and nurseries in 2018	22
Figure 4: Distribution per species of 2018 aquaculture production in the treatment provinces	23
Figure 5: Distribution of loans granted by MFI to the different types of respondents	24
Figure 6: Loan amount disbursed by MFI to aquaculture value chain actor in 2018 in control and treatment provinces.	25
Figure 7 : Production calendar and selling period for different actors of the aquaculture value chain (S: stocking fingerlings; H: Harvesting fish)	28
Figure 8: Average amount of feed sold by feed distributors during 2018 peak season in treatment (n=15) and control (n=7) groups	28
Figure 9: Number of fingerlings sold by hatcheries and nurseries in treatment provinces in 2018 (see Annex F, Table I)	30
Figure 10: Distribution of pond and cage fish farm by class size in control and treatment provinces	31
Figure 11: Average stocking density in ponds (fish/m ²) and cages (fish/m ³) of the three most common aquaculture species	32
Figure 12: Feeding practices of producers in the different treatment and control provinces.	32
Figure 13: Type of information received by aquaculture producers	33
Figure 14: Collectors, wholesalers, processors volume and origin of fish purchased in 2018 in treatment provinces	34
Figure 15::Percentage of respondent using loans in the treatment and control groups	35
Figure 16: Percentage of respondents who received aquaculture related training in the past	36
Figure 17: Aquaculture training received by respondents between 1998 and 2018 in treatment (left) and control (right) groups.	37
Figure 18: Percentage of producers affected by drought and flood and equipped with a well in treatment and control provinces	39
Figure 19: Cluster of producers (number of farms within 5 km radius), hatcheries and nurseries surveyed in treatment provinces. The circle symbol is sized to portray a central point of each cluster based on the number of aquaculture farms fall within the cluster	40
Figure 20: Average number of production assets of fish farmers and hatcheries	42
Figure 21: Average number of transportation assets of collectors, wholesalers and processors in control and treatment provinces	42
Figure 22: Total value (Million US\$) and volume (thousand metric ton) Cambodian product sold by producers, collectors, wholesalers and processors in treatment provinces.	43
Figure 23: Distribution of adoption of improvement management practices in treatment and control groups of producers	45
Figure 24: Distribution of adoption of improvement management practices of collectors, wholesalers and processors in treatment (T) and control group (C)	46
Figure 25:: Percentage of wholesalers and processors that claimed to receive market information about i) processed fish price; 2) live and dead on ice fish price; 3) fish quality and standard.	48

List of Tables

<i>Table 1: Study respondents' definition</i>	10
<i>Table 2: Summary of sample for each category in treatment and control groups</i>	12
<i>Table 3: Surveyed population per province</i>	12
<i>Table 4: Modification in data collection method and sampling method during survey implementation</i>	14
<i>Table 5: Key topics covered during the interviews and audience</i>	18
<i>Table 6: Characteristics of the surveyed population</i>	27
<i>Table 7: Access to loan by different type of respondents</i>	36
<i>Table 8: List of major landing site for aquaculture products</i>	40
<i>Table 9: List of major processing hubs</i>	41
<i>Table 10: Results about Standard indicator #4; Custom indicator #11, Custom indicator #5 and perception of the quality of Cambodian aquaculture product (related to Custom indicator #10) in treatment provinces</i>	47
<i>Table 11: Potential confounder variables influencing CAST outcomes</i>	50

Abbreviations and Acronyms

ASA	American Soybean Association
BAqMP	Best Aquaculture Management Practice
BMP	Best Management Practice
CAST	Commercialization of Aquaculture for Sustainable Trade
CE SAIN	Center of Excellence for Sustainable Agricultural Intensification and Nutrition
DID	Difference-in-differences
FiA	Fisheries Administration
FFPr	Food for Progress
IPTT	Indicator Performance Tracking Table
ha	hectares
HORECA	Hotel, Restaurant & Caterers
KII	Key informant interview
LOP	Life of Project
MFI	Micro-finance institution
MT	Metric tons
PMP	Project Monitoring Plan
PSM	Propensity Score Matching
SPS	Sanitary-phytosanitary
USDA	United States Department of Agriculture
WISHH	World Initiative for Soy in Human Health

EXECUTIVE SUMMARY

Introduction

Commercialization of Aquaculture for Sustainable Trade (CAST), Cambodia, is a new project funded by the U.S. Department of Agriculture (USDA), Food for Progress (FFPr) Program. The five-year program, signed in September 2018, is being implemented by American Soybean Association's (ASA) World Initiative for Soy in Human Health (WISHH) Program. The project supports the USDA's FFPr principal objectives of increased agricultural production and trade, by increasing the use of improved agricultural techniques and technologies among target populations, and improving linkages between buyers and sellers.

To achieve the main objectives, the project will be supporting 10 activities:

- Activity #1: Capacity Building: Agricultural extension agents/services
- Activity #2: Inputs: Develop agro-dealers and/or other input suppliers
- Activity #3: Training: Improved farm management
- Activity #4: Training: Demonstration plots
- Activity #5: Training: Sanitary and phytosanitary standards (SPS)
- Activity #6: Capacity Building: Business management
- Activity #7: Capacity Building: Producer groups/cooperatives
- Activity #8: Training: Improved marketing and branding
- Activity #9: Market Access: Facilitate a traceability system for domestic aquaculture
- Activity #10: Financial Services: Provide SME finance, technical assistance loans and grants

CAST engaged WorldFish in March 2019 to conduct a baseline evaluation for the project. The purposes of the baseline study were:

- i) to provide baseline data for the Project Monitoring Plan (PMP), and serve as the basis for updating baseline figures for all outcome indicators, and the yearly and life-of-project (LOP) targets, as described in the Indicator Performance Tracking Table (IPTT).
- ii) to provide the benchmark for the project's midterm and final evaluations.
- iii) to provide contextual information and a situation analysis of the aquaculture sector information to validate and inform the project's interventions.

Methodology

The study was conducted from April to August 2019, including data collection using mixed methods in six treatment provinces and Phnom Penh municipality, and three control provinces of Cambodia. The data collection consisted firstly, of a Population Based Survey (1,204 producers and 191 other actors, including hatcheries, nurseries, producers, fish collectors, fish processors, fish wholesalers, feed mills, feed distributors, micro-finance institutions) framed as a quasi-experimental design with a treatment and control groups. Secondly, a qualitative study was based on 46 Key Informant Interviews (KII). The baseline study focused on "commercial" aquaculture farmers, as defined by ponds larger than 200m² and cages more than 30m³. These included small, medium, and large-scale farms, and did not include subsistence or micro-scale producers. The quantitative survey questionnaire covered thematic modules on human resources, farm assets, production and sales, management practices, access to knowledge and training, and loans, for the 2018 calendar year.

All the data were collected and compiled using Kobo Toolbox on digital tablets. The survey data were stored and analyzed using STATA 14 (standard and custom indicators and

Propensity Score Matching), Excel 2016 (situation analysis) and R software (covariate analysis). The KII data were analyzed using Nvivo 12.

Baseline research questions

What is the current productivity of feed mills, aquaculture producers and hatcheries and nurseries?

The average yield of aquaculture was 4.8 kg/m²/year in ponds, and 44 kg/m³/year in cages. However, the range for both production systems varied widely, due to differences in production intensity between species¹. The production intensity was generally low; the average productivity in pond culture of *Pangasius* in Cambodia achieved less than 25% of a similar system in Vietnam², in terms of kg/m².

On average, hatcheries produced 1.2 million fingerlings annually, although there was a wide range in hatchery performance, from less than 0.3 million fingerlings to 7 million. Nurseries in the treatment provinces traded about twice as much fingerlings as the total produced by 17 hatcheries surveyed in the same provinces. Hatcheries in Vietnam are the main source of fingerlings in Cambodia in both control and treatment provinces. There were no feed mills producing aquaculture feed in Cambodia in 2018.

What is the current soy protein and fish product trade in Cambodia?

Soybean production in Cambodia increased from 40,758 metric tons (MT) in 2016 to 91,729 MT in 2018. The volume of soybeans (beans, meal and cake) imported from the U.S. reached 51,000 MT in 2017, or US\$19 million in value³. None of the feed mills interviewed reported the U.S. as a main source of soymeal for their animal feed ingredients.

Thirteen thousand MT of fresh and processed fish products were exported from Cambodia in 2017. Major destinations for the fish products were Thailand and Vietnam. Capture fisheries are considered to be the main source of export products.

What is the current quantity and quality of feed and seed produced for aquaculture producers and its availability and accessibility?

All manufactured pellet feed sold in Cambodia was imported. One feed mill was starting aquaculture feed production in Cambodia, but still in the development phase at the time of interview. This feed mill planned to comply with international quality standards. The feed distributors surveyed sold one to four brands of feed, and nearly all reported that at least one of the products met at least one international standard. The average volume sold by the surveyed distributors during the peak growing season was 23.4 MT, varying from 1.5 MT to 54 MT per distributor.

A total of approximately 20.3 million fingerlings, of unknown quality, were produced annually in the treatment provinces. Similarly, imported fingerlings were of unknown origin and quality. *Pangasius*, tilapia, and carps were the main species produced by local hatcheries, while catfish and snakehead were the main species sold by nurseries. Ninety-five percent of the total volume of *Pangasius* fingerling production in Cambodia came from a single hatchery. Average price of one *Pangasius* fingerling produced by local hatcheries was US 2.4 cents, while nurseries sold one fingerling of the same species for US 2 cents. A similar pattern was

¹ For example, *Pangasius* stocking density in cage was estimated to 76 ind/m³ and 244 ind/m³ for *Channa striata*

² http://www.fao.org/fishery/culturedspecies/Pangasius_hypophthalmus/en

³ GATS, USDA for US export to Cambodia.

https://www.fas.usda.gov/data/search?f%5B0%5D=field_commodities%3A27 [accessed July 2019]

observed for tilapia and carp. This indicated that imported fingerlings were far more available and accessible to aquaculture producers, through licensed and unlicensed nurseries that primarily traded imported fingerlings. No Cambodian producer or importer supplied certified seed at the time of the survey.

What is the current supply of premium quality, Cambodian-grown freshwater fish to the local market?

The surveyed commercial aquaculture producers in treatment provinces sold a total of 7,941 MT of fish per year, dominated by *Pangasius* and giant snakehead. Top producer provinces were Phnom Penh, Pursat and Battambang. Collectors and wholesalers surveyed in treatment provinces reported purchasing a total of 8,820 MT of fish from Cambodian aquaculture producers.

None of the producers or post-harvest actors followed any recognized standard procedure in both control and treatment provinces. However, perceived quality of the Cambodian aquaculture fish by post-harvest actors was either “good” or “very good” in 70% of the respondents, and the average spoilage rate was estimated by the survey respondents to be below 5%.

What is the current beneficiaries’ ability to access finance that is needed for business growth and development?

Forty-eight percent of the respondents had contracted a loan from formal Micro Finance Institutes (MFIs) or informal sources. Fish producers were the category of respondents with the highest percentage of loans (51%). Twenty-four percent of the producers contracted loans from MFI or banks, mostly to purchase fish feed.

MFIs interviewed in treatment provinces reported an average of 12 loans each, disbursed to aquaculture value chain respondents. The average size of these loans was \$26,375, with very high variability ($\pm$ \$25,250). Fish producers’ contracted 58% of those loans, also with high variability ($\pm$ \$32,000 $\pm$ \$30,250). Interest rates charged by MFIs were high (13% per year).

Where are clusters of active SME farms and hatcheries that meet the selection criteria as potential beneficiaries of CAST?

In the treatment provinces, we identified 50 clusters of producers within a five-kilometer radius. Those clusters varied in size, from three producers to more than 80 producers. Largest clusters are found in floating villages on the Tonle Sap Lake.

Where are existing value chain networks at provincial level that can be strengthened to meet CAST objectives?

We identified seven major wholesale fish markets (locally called “landing sites”) where aquaculture fish are traded. Those landing sites are located in Siem Reap, Kampong Cham, Pursat, Battambang Provinces and Phnom Penh. In addition, we identified 12 “processing hubs” in seven provinces, where dried fish, fermented fish, and smoked fish are produced at commercial scale. We did not find any semi-industrial fish-processing hub.

Who and where are existing or potential extension service agents that can become core facilitators of value chain networks?

Aquaculture extension services are not functioning well in Cambodia. However, we found the private sector can be a source of knowledge and information diffusion to support adoption of improved management techniques. Forty-one percent of the feed manufacturers provided

technical support to feed distributors. Feed distributors mostly supported farmers with technical advice at the shop, but also had technicians supporting farmers directly. On average, one feed distributor supports 13 producers.

What are the constraints and opportunities within various segments of the commercial aquaculture value chain in Cambodia?

Access to quality fingerlings and manufactured feed is limited. Fingerlings of the main commercial species are imported and local production is limited. Those imported materials are of unknown origin and quality. The high price of imported feed hindered wide spread use by producers. We found limited adoption of improved technology and practices used in all segments of the value chain, resulting in low productivity and performance of the production systems. There is no standard procedure in production and post-harvest segment.

However, the demand for local aquaculture fish, considered to be of higher quality than imported products, was found to be significant. Access to lower priced inputs, and improved efficiency of input use at the farm level would improve economic competitiveness of aquaculture products on the local market.

Key findings and recommendations

Aquaculture production and quality were sub-optimal for the cultivated area. Low quality inputs, especially fingerlings of unknown origin, hindered productivity. Production systems were not diverse. However, significant differences in terms of production systems, volume, and level of management practices across provinces indicated high potential for increasing both the quantity and quality of fish produced by existing aquaculture producers.

Competition from low cost, imported fingerlings was the biggest challenge to Cambodian hatcheries. The feed supply would continue to rely on imported products for the foreseeable future, as the domestic feed production was still at a developmental stage. Formal loans from MFIs used interest rates that were prohibitively high for small- and medium-scale operators with limited profit margins. With improved access to financial and technical assistance, the producers may gain more confidence for investing in improved feed and feeding regimes.

The findings of the CAST Baseline Study are consistent with recent reviews and value chain studies of the sector. The sector is dependent on imports for inputs and the practices and performance of the sector are sub-optimal. The value chains are inefficient, and neither vertically nor horizontally integrated. Those challenges can be grouped into two categories related to i) aquaculture production and quality and ii) value chain efficiency. Therefore, various CAST sub-activities need to be implemented in a coordinated manner to achieve performance improvements in productivity and quality at the same time as the improvement in access to market and profitability.

Based on these findings, it is recommended that the CAST Activities #1, #2, #3, #4, and #10 consider the following strategies to address challenges related to aquaculture production and quality:

- Focus the project interventions, initially, on existing producer clusters, in selected locations, and key species, and use an “incremental innovation approach” to gradually upgrade management practices of producers, particularly feeding.
- Focus the technical interventions, initially, to support a large number of pond-based producers who can improve the productivity through relatively simple changes in water management and pond preparation.

- Develop Best Aquaculture Management Practice (BAqMP) guidelines for CAST, that can later inform the contents of future national Best Management Practices (BMP) to be developed by the Fisheries Administration.
- Develop model farms, for both ponds and cages, to demonstrate improved production techniques as well as effective business models.
- Apply an integrated approach to address financial and technical obstacles simultaneously throughout the production and post-harvest value chain.
- Support MFIs and insurance companies to gain improved understanding of aquaculture-related businesses and assess their financial performance and lending risks.
- Support climate change adaptation by identifying key communes and districts where access to water is a constraint and/or frequently affected by flooding.

Demand for quality aquaculture fish produced in Cambodia is increasing, but the current production level, and the capacity of local producers, is too low to meet this demand. A reliable mechanism for assuring traceability and quality standards, such as third-party certification, or a “block-chain” mechanism using digital technology, needs to be established. Without such system, it is difficult for products that meet certain consumer preferences and market niches to gain premium prices. These premiums will, in turn, attract more producer compliance, and gradually lead to an overall improvement in the industry. The hygiene standards and fish handling/transportation technologies of post-harvest operators need to be improved as a priority.

Fish buyers and traders are often the only source of market information for producers, and thus have distinct advantage over the producers. Many producers are also tied to particular buyers through debt. Improved access to other financial services, market information, and alternative models of trading and marketing, can improve the negotiating position and profit of producers in the value chain.

Based on these findings, it is recommended that the CAST Activities #5, #6, #7, #8 and #9 consider the following strategies to improve value chain efficiency:

- Enhance and expand the existing networks of hatcheries/nurseries and producer clusters to include post-harvest operators, to improve the quality and flow of new knowledge and technology, and market information to the producers, and demonstrate a more transparent and equitable value chain.
- Improve business management practices at individual farm and business operator level, to promote self-sufficiency, and avoid over-reliance on external subsidies.
- Identify markets for higher quality fish and fish products, before engaging in training. Training for improved hygiene and quality, as well as traceability system should be demand driven
- Provide training and awareness raising on hygiene and quality control, and develop a traceability system, that responds to specific market demand for certain types of fish and fish products.
- Focus on key species (*Pangasius* and snakehead) and product (dry and smoked fish) and also include live-fish when developing improved post-harvest and marketing practices.
- Facilitate alternative contractual arrangements between producers and buyers (such as group contracts), and pricing systems (such as collective marketing and/or auctioning of farmed fish).
- Support for the traceability and SPS mechanisms should initially focus on a limited number of commodities or products, as a pilot, such as *Pangasius* or giant snakehead,

that are already linked, with a relatively well-organized value chain, to major consumer markets in urban areas.

- Develop an SPS scheme for CAST, in line with existing SPS in the aquaculture industry in Southeast Asia, and start testing the implementation in collaboration with the Cambodian government and private sector.
- Provide support to value chain actors that have limited access to formal loans to develop robust business models and plans to facilitate improved access to formal loans.

1. INTRODUCTION

In the 2018 fiscal year, the U.S. Department of Agriculture (USDA) entered into a new award for the Food for Progress (FFPr) Program. The FFPr program has two principal objectives: to improve agricultural productivity and to expand trade of agricultural products. The FFPr program provides for the donation of U.S. agricultural commodities to developing countries and emerging democracies, committed to introducing and expanding free enterprise in the agricultural sector.

Commercialization of Aquaculture for Sustainable Trade (CAST), Cambodia is a new five-year program under FFPr, signed in September 2018, and implemented by the American Soybean Association / World Initiative for Soy in Human Health (WISHH). The project supports the USDA FFPr principal objectives by increasing the use of improved agricultural techniques and technologies among target populations and improving linkages between buyers and sellers. The two main objectives of CAST Cambodia are:

- Increase agricultural productivity in the freshwater aquaculture industry through improved inputs and practices; and
- Increase trade in Cambodian aquaculture, by volume and value.

To achieve the main objectives, the project will be supporting 10 activities:

- Activity #1: Capacity Building: Agricultural extension agents/services
- Activity #2: Inputs: Develop agro-dealers and/or other input suppliers
- Activity #3: Training: Improved farm management
- Activity #4: Training: Demonstration plots
- Activity #5: Training: Sanitary and phytosanitary standards (SPS)
- Activity #6: Capacity Building ; Business management
- Activity #7: Capacity Building: Producer groups/cooperatives
- Activity #8: Training: Improved marketing and branding
- Activity #9: Market Access: Facilitate a traceability system for domestic aquaculture
- Activity #10: Financial Services: Provide SME finance, technical assistance loans and grants

These activities are linked to the USDA FFPr Results Framework #1 *Increased Agricultural Productivity*. Two key “results streams” will lead the achievement of this Strategic Objective: Result Stream 1, under the result *Increased Use of Improved Agricultural Techniques and Technologies* and Result Stream 2, under the result *Improved Farm Management (Operations, Financial)*. CAST project activities are also linked to FFPr Results Framework #2: *Expanded Trade of Agriculture Products* on domestic, regional, and/or international levels. Results Framework #2 possesses three key “result streams”: Result Stream 1, under the result *Increased Value Added to Post-Production Agricultural Products*; Result Stream 2, under the result *Increased Access to Markets to Sell Agricultural Products*; and Result Stream 3, under the result *Improved Transaction Efficiency*.

In addition, activities are related to foundational results that are linked to either Result Framework #1 or #2. Those foundational results are:

- *Increased Capacity of Government Institutions*
- *Improved Policy and Regulatory Framework*
- *Increased Access to Improved Market Information*
- *Improved Capacity of Key Groups in the Agriculture Production Sector (i.e. cooperatives and small shareholder farmers)*
- *Increased Leverage of Private Sector Resources (i.e. cost-sharing or leveraging of private sector resources, either cash or in-kind, that seeks to improve production infrastructure)*

The project will implement these activities in six provinces (Kampong Cham, Kampong Thom, Siem Reap, Battambang, Pursat, Kandal) and Phnom Penh in Cambodia.

In line with the USDA's Monitoring & Evaluation Policy, updated in February 2019, CAST Cambodia contracted WorldFish to perform a baseline study of the program (see Annex A – Terms of Reference). The purposes of the baseline study are:

- i) to provide baseline data for the Project Monitoring Plan (PMP) and serve as the basis for updating baseline figures for all outcome indicators and the yearly and life-of-project (LOP) targets described in the Indicator Performance Tracking Table (IPTT).
- ii) to provide the benchmark for the project's midterm and final evaluations.
- iii) to provide contextual information and a situation analysis of the aquaculture sector to inform the project interventions.

This baseline survey is the first phase of a pre-post evaluation. The second phase comprises an end-line survey or final evaluation, following project completion.

This baseline report is organized as follows. We first present the methodology used in both quantitative and qualitative surveys (Section 2). Section 3 presents answers to the baseline research questions. Situation analysis (Section 4) gives an updated picture of the aquaculture sector in the treatment and control provinces. Section 5 presents the evaluation of baseline standard and custom indicators and provides details on organization and performance of the sector. Co-variate and confounder analysis are presented in Section 6. In Section 7 we present findings of the qualitative study. Key findings are presented in Section 8 before presenting the recommendations for project implementation and M&E in Section 9.

2. METHODOLOGY

The study uses a mixed-methods approach, involving quantitative and qualitative investigations. The quantitative component adopts a quasi-experimental design in which nine different types of potential project beneficiaries, across the six treatment provinces and Phnom Penh municipality, and three control provinces, are surveyed for their performance and current practices. The qualitative component consists of key informant interviews (KIIs) with different actors within the aquaculture value chain.

Following are details of the methods deployed to answer baseline questions and calculate baseline figures for the associated Standard and project-specific (Custom) indicators, as well as detailed information on performance and organization of the sector to inform project intervention.

2.1 Methods for population-based survey

2.1.1 Survey design and objectives

The primary objective of the population-based survey was to establish baseline figures for key project indicators in the program's IPTT, to be approved by USDA before the project implementation period begins in October 2019. To quantify the impact of the project intervention on target outcomes during the final evaluation, we recommend that the CAST project use a Difference-in-Differences (DID) approach, which compares the before-after changes in outcomes between individuals in the intervention group and those in the control group.

Data analysis is to set the stage for the use of the DID methods during the final evaluation. In order to increase accuracy of impact evaluation, and avoid bias due to differences between control and treatment groups, we conducted a Propensity Score Matching (PSM) to match individuals from control groups with individuals from treatment groups. The matching is done at the farm level and based on farm characteristics. After matching, it is expected that there

will be no significant differences in characteristics (control variables) between treatment and control groups for those farm characteristics and thus adequate comparative analysis of farm performance can be done during the final evaluation.

2.1.2. Respondents and study areas

For the purpose of conducting an impact evaluation at the end of the project, the baseline was based on a binary approach with treatment and control groups. The baseline sample was selected based on the list of potential project participants, considering project participation and geography to define treatment and control groups.

The treatment group covers the six CAST-selected provinces (Kampong Cham, Kampong Thom, Siem Reap, Battambang, Pursat, Kandal) and Phnom Penh. The control group covers three provinces: Takeo, Banteay Meanchey (pond aquaculture) and Kampong Chhnang (cage aquaculture). This group is well representative of the diversity of aquaculture production systems (Figure 1 **Error! Reference source not found.**). Kampong Chhnang has been selected to represent aquaculture production using cage technology, whereas Takeo and Banteay Meanchey represent pond technology. Banteay Meanchey was also selected to include within the control group the influence of Thailand on the aquaculture sector. Takeo is included in the control group to mirror the influence of Vietnam. In addition, a Japanese funded aquaculture project was operating in Takeo (2005-2010) and Banteay Meanchey (2011-2015) Provinces. Cambodia HARVEST, a USAID funded project operated in treatment provinces (Siem Reap, Kampong Thom, Battambang, and Pursat) between 2010 and 2016. During the timeframe of CAST project, a large EU funded project, implemented by the Fisheries Administration and Agence Française de Développement (Afd), named EU-CAPFishAqua, will be deployed 2019 -2025. The province of intervention of this project is not yet finalized but it will surely overlap with provinces included in the treatment and control group.

The population-based survey encompasses nine groups of value chain respondents: hatcheries, nurseries, producers, fish collectors, fish processors, fish wholesalers, feed mills, feed distributors, and micro-finance institutions. For the purpose of this study, definition of these value chain respondents is provided in [Table 1](#). Note that the survey focused on commercial aquaculture, including smallholder farms, but excluded subsistence farmers and micro-scale producers, with pond area smaller than 200m² or cage volume smaller than 30m³. This choice was motivated by the fact that CAST project focus on commercial aquaculture and will not work with subsistence farmers.

First, the treatment and control populations were clustered by province. In the second step, a random sampling procedure was used to ensure a representative sample of the farms, for both cage and pond producers, across the treatment and control provinces. Details of the sampling procedure are found in Section 2.1.4.

For other respondents (feed mills, hatcheries, nurseries, feed distributors, processors and wholesalers), due to the small size of the population considered, we used a *descriptive statistics of a purposive sample* to allow comparisons of the quantitative values before, during, and after the project interventions.

Table 1: Study respondent definition

Respondents	Definition
Hatcheries	Actors who are producing at least 100,000 fish fry and fingerlings per year in Cambodia, to sell to producers and/or to nurseries.
Nurseries	Actors who are purchasing fry and/or fingerlings from a hatchery (including abroad) to nurse them for a variable period, to re-sell later to producers.
Producers	Actors who are producing fish for income generation. They operate production units larger than 200m ² (pond) or 30m ³ (cage) and are selling more than 80% of their production.
Collectors	Actors who are buying fish at the farm level and selling fish to wholesalers/processors; some of these individuals/actors may also sell some fish to the end user/consumer
Wholesalers	Actors who are buying fish either directly at the farm or from collectors. Wholesalers re-sell fish to retailers at market, restaurants, caterers or processors. Their transportation and trading capacity is larger than collectors (car or trucks)
Processors	Actors who are buying fish either directly at the farm, from collectors, or wholesalers. Processors can be still family based, but with long term or seasonal employees. Processors transform the “raw material” (fish) before marketing their products
Feed distributors	Local businesses who are managing shops that sell aquaculture feed and other inputs used to culture fish
Feed mills (managers)	Manager of factory where animal feed is processed. It can be animal feed for chicken, pork or fish production.
Micro-finance institutions	Bank or formal MFI providing loans to actors within the aquaculture value chain

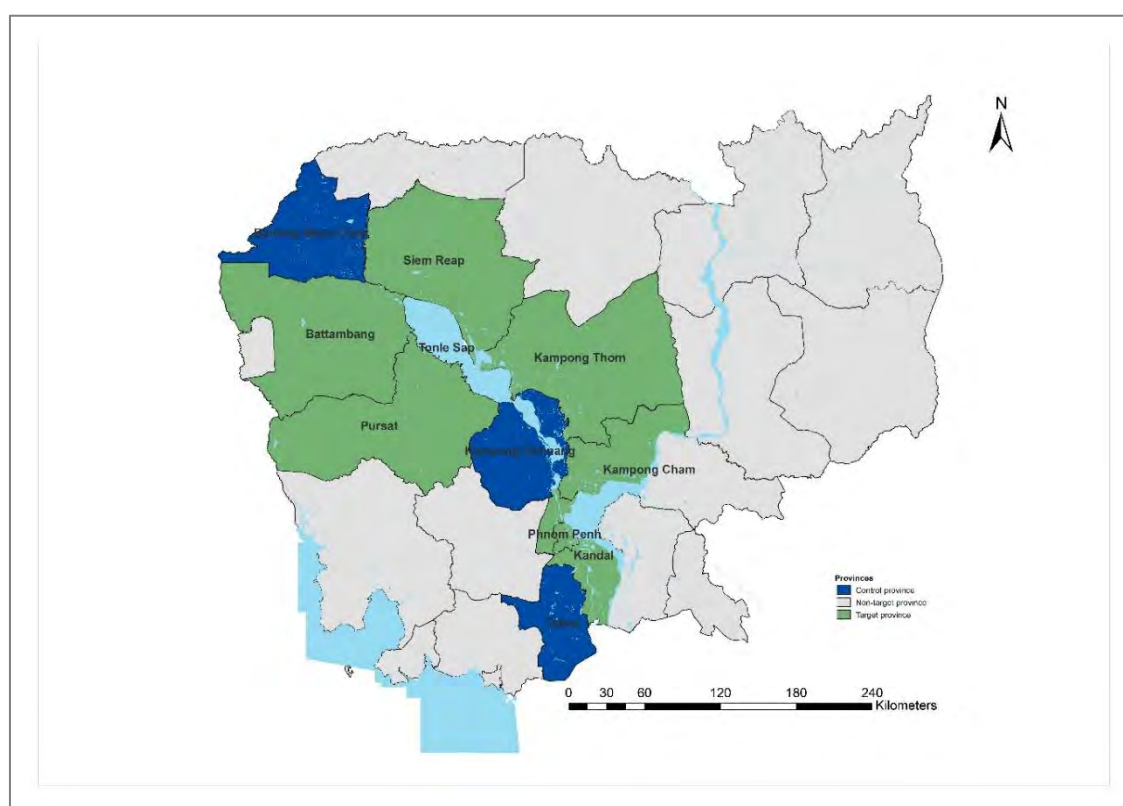


Figure 1: Treatment (green) and control (blue) provinces of CAST program

2.1.3. Understanding the population of interest

Information related to aquaculture producers and stakeholders in the value chain is scarce in Cambodia. To estimate existing population and inform sample size we triangulated secondary sources of information and conducted a scoping exercise in each of the treatment and control province to verify information and identify potential survey respondent.

To achieve this, we triangulated secondary sources of information, including statistics collected from several governmental sources (e.g., 2015 Cambodia Socio-Economic Survey; Fisheries Statistics at provincial level) and past aquaculture projects, to identify clusters of aquaculture producers that responded to CAST project beneficiary criteria. The data informed the scoping exercise in identifying districts and communes where aquaculture operations are concentrated. This information was verified during the scoping exercise.

During April and May 2019, three WorldFish researchers conducted field missions to treatment and control provinces, and collected lists of producers and other respondents at district and commune levels in collaboration with the Fisheries Administration Cantonment Officers.

The team collected updated information about fish farmers and other CAST targeted respondents, with input from Fisheries Administration (FiA) Cantonment officers, local authorities and key stakeholders of the aquaculture value chain. The researchers followed the same procedure in each province:

- Contacting local FiA authorities to inform them about the plans for the scoping exercise and the upcoming survey
- Identify, in collaboration with FiA Cantonment officers, key stakeholders of the value chain and list producers and other potential respondents responding to project criteria.
- Collect the name and contact information of the respondents and/or local village leaders to facilitate survey organization and implementation.

The scoping resulted in identifying 1,617 potential respondents in the aquaculture producer category and 406 respondents in the other categories (hatcheries, nurseries, post-harvest actors, feed mills, and feed distributors).

2.1.4. Sample design

Based on the sample size calculating formula⁴, a 3% margin of error, and a 95% confidence interval, the total population of aquaculture farmers in each province was used to determine the target sample size for aquaculture farmers. The sample size at the provincial level for aquaculture farmers was adjusted for an expected response rate of 70%. Using this method, the sample size of the treatment group was determined as 894 respondents. The sample size for the control group was revised upward to 300, from the initial target of 260 respondents. This addressed possible heterogeneity due to different aquaculture technology (pond and cage), and in anticipation of potential future drop-off of some farmers from aquaculture business, that could undermine the final evaluation process due to a reduction in the sample size of the control group.

During implementation of the survey, the random sampling was partially abandoned as the listing was not accurate enough (producers already stopped aquaculture activities or not corresponding to the CAST criteria of beneficiaries). Those aquaculture farmers were replaced

⁴ Formula calculating sample size:

$$n = ((z^2 r(1-r))/e^2) / (1 + (z^2 r(1-r))/(e^2 N))$$

Where, n = Sample size; z = z-score (following the normal distribution); N = Population size; r = Response distribution, assumed at 50%

(58% of total sample) by other farmers corresponding to the criteria in order to achieve the target sample size. In addition, two districts in Battambang Province were added to the sampling framework in order to achieve the target sample size. The selection of new farmers and new districts was performed during the survey and in collaboration with village authorities who have detailed and updated information about aquaculture activities. **ANNEX B: SAMPLING FRAMEWORK** presents the details of those changes.

Thus, the sampling has shifted to *purposive selection*, achieving much higher representativeness of the target beneficiary farms than would have been possible with random sampling.

The total population of other respondents was estimated at 406 (Table D, **ANNEX B: SAMPLING FRAMEWORK**), in the treatment and control provinces. Of this population, we selected a sub-sample, with the following criteria, per province: i. all feed mills in activities; ii. three micro-finance institutions; iii. three feed distributors⁵; iv. three wholesalers; v. five collectors; vi. 30% of the existing medium scale fish processor; vii. all hatchery operations; viii. 10 nurseries⁶.

Table 2: Summary of sample for each category in treatment and control groups

	Aquaculture Producers			Other value chain actors (purposive sample)							
	Total Number of producers	Planned sample size	Number of producers surveyed	Feed mills	Hatcheries	Nurseries	Processors	Wholesalers	Collectors	Feed distributors	Financial institutions
Treatment Provinces	1209	894	918		17	8	26	21	24	17	11
Control Provinces	408	300	286	8	13	1	8	8	16	7	6
Total	1,617	1,194	1,204	8	30	9	34	29	40	24	17

Table 3: Surveyed population per province

	Producers	Hatcheries	Nurseries	Collectors	Wholesalers	Processors	Feed distributors	Feed mills	MFI
Treatment Provinces									
Phnom Penh	70	0	1	3	4	3	1	6	1
Kandal	99	2	1	3	2	2	0	1	1
Kampong Cham	137	3	2	1	4	2	2	1	1
Kampong Thom	109	1	1	5	3	8	3	0	1
Siem Reap	162	3	1	3	3	5	3	0	3
Battambang	96	5	2	4	2	4	5	0	2
Pursat	245	3	0	5	3	2	3	0	2
Control Provinces									
Takeo	106	12	1	5	3	2	3	0	3
Kampong Chhnang	146	1	0	6	4	4	3	0	2
Banteay Meanchey	34	0	0	5	1	2	1	0	1

⁵ Feed distributors have been selected from i) a list of CAST project partners and ii) when not available in the province additional feed distributors were selected with a single criteria (currently sell aquaculture)

⁶ Licensed nurseries were selected in the existing provinces

Using these categories of actors, in treatment and control populations, a final sample of 1,395 respondents was realized. Table 2 and 3 summarize the distribution of producers and respondents in Control and Treatment provinces. The detailed sampling framework is described in Annex B and observed differences between our planned and realized survey is detailed in Section 2.1.6.

2.1.5. Questionnaire design

The survey questionnaires (see **ANNEX C: QUESTIONNAIRES & SURVEY TOOLS** for the English version of the questionnaire) were developed through consultation with local aquaculture experts, CAST team, and the Fisheries Administration. The questionnaire was designed to capture the data and information needed for the indicators and the level of disaggregation required for each type of respondents using the *USDA FFP Standard Indicators Handbook*⁷. Definitions for program-specific indicators were discussed and confirmed with CAST before drafting the questionnaire.

The questionnaire is composed of 15 thematic modules⁸, that cover all indicators for all applicable beneficiary groups (**ANNEX C: QUESTIONNAIRES & SURVEY TOOLS**). To minimize errors, speed up data collection, and facilitate quality control, a digital tablet-based data collection application was utilized: KoBoToolBox⁹. To reduce the complexity of programming the questionnaire in KoBoToolBox, the questionnaire was split into five digital questionnaires based on actors' typology (1: aquaculture producers; 2: post-harvest actors and feed distributors; 3: feed mills; 4: micro-finance institutions; 5: nurseries and hatcheries). Data collected for the Baseline survey covers the period of production and trade in the 2018 calendar year.

For training enumerators, WorldFish developed a glossary of key terms and a Powerpoint presentation that illustrated key techniques and terms related to aquaculture in Cambodia. Nuppun Research and Consulting facilitated enumerator training May 21st – 23rd in Phnom Penh. A representative of WorldFish staff was present during all the sessions to provide technical guidance regarding aquaculture. The training covered topics such as supervisor roles and responsibilities, behaviors and ethics, and GPS data collection. Also included was a detailed review of the producer's survey questionnaire with group practices and mock interviews and role playing. Twenty-five enumerators and five field supervisors joined the training and field testing. Producer questionnaires were field tested on May 29th in four villages in Kampong Chhnang Province, and the questionnaire was finalized¹⁰ after feedback from the team on May 30th. Questionnaire for other respondents was tested in Kandal Province on June 23rd and updated on June 24th. Field testing was the opportunity to verify the functioning of digital survey tool (skipping logic, data capture and transfer to server), question phrasing, units of variables¹¹, and logic within the different modules.

Based on the feedback from those exercises, several questions needed to be re-phrased, units updated to fit local practices or complemented with additional pre-determined choices.

⁷ Food Assistance Indicators and Definitions. Foreign Agricultural Service – Food Assistance Division. United States Department of Agriculture. February 2019

⁸ A: Registration; B: human Resources; C: Farm Assets; D: Post harvest equipment; E: Hatcheries sales & production; F: Nurseries stocking and sales; G: Producers; H: Management practices; I: Trade of fish (live, chilled and processed); J: Quality post-harvest; K: Knowledge and training; L: Finance and access to loan; M: Feed mills; N: Micro-finance and Banking; O: Feed distributors

⁹ <https://www.kobotoolbox.org/>

¹⁰ For example, the fish species included in the questionnaire or the capture of production cycle needed to be updated

¹¹ For example, certain value capture in KHR needed to be changed to be capture in million KHR as KoboToolBox does not allow integer of more than 9 digits.

2.1.6. Field work

Fieldwork occurred June 5th to July 12th, in two phases. The first phase (June 5th to July 5th) surveyed fish producers, and a second phase (June 27th to July 12th) surveyed other actors of the value chain. All survey interviews were conducted in Khmer language. The aquaculture producer survey was carried out by five teams, each consisting of a field supervisor and five enumerators. The survey of other value chain actors was conducted by three teams, each consisting of a field supervisor and 2-3 enumerators.

Table 4: Modification in data collection method and sampling method during survey implementation

Content area	Original plan	Change made	Rationale
Sampling approach and strategy	Random selection of respondents based on data collecting during scoping exercise	No longer random, but <i>purposive</i> . Adjustment of rules due to: - logistic issues by substituting and replacing farmers in remote area by farmers located near other sampled farmers - low accuracy of listing of aquaculture producers. Replacement by other farmers in the same commune.	To effectively select farmers that responded to CAST beneficiary selection criteria and collect the targeted sample size
Data collection for purposive sample	Respondents to be interviewed in person	10 MFI and one feed mill, interviews were conducted over the phone.	To ensure accuracy of administrative data as respondent need to check his/her record to answer the question(s) Limit transport cost and time to provinces
	Key Informant Interview selected within the Purposive sample	Select another respondent for KII or purposive sample selection due to survey fatigue (3 cases)]	Survey fatigue of respondent having to respond to two surveys within one month increased non-response rate
Approach to MFI	Approaching MFI directly at provincial level	Approaching MFI at Headquarter in Phnom to get access to information in province	MFI office in province were reluctant to respond to our survey

For both surveys, one survey manager oversaw the entire process, and one data manager oversaw the data upload on Kobo ToolBox server¹². All interviews were conducted face-to-face, but interviews with MFIs were performed by phone, due to the short length of the questionnaire and the other reasons described in [Table 4](#). Questionnaires were sent in advance by e-mail, as respondents needed to consult their records to answer the survey. The survey data were GPS-referenced to facilitate replication of surveys for the final evaluation and project activities.

The data collection occurred on the farm premises, unless logistical or transportation constraints prevented the enumerator's visit (e.g., in about 30% of the floating villages, corresponding to 130 farms and about 10 other farms in Battambang where interviews occurred at the house of the producer). During survey implementation, several modifications to the plan were required to fit the local context ([Table 4](#)), notably the inaccuracy of the listing of commercial aquaculture producers developed in collaboration with FiA Cantonments.

¹² <https://kobo.humanitarianresponse.info/accounts/login/?next=/#/>

Seventy-percent and 54% of the sample farmers in control and treatment provinces, respectively, needed to be replaced with newly identified farmers, on-site, because the originally selected sample farmers turned out to be inactive in aquaculture production, or did not meet the CAST beneficiary criteria in terms of farm size and production volume. Consequently, for the districts surveyed, the final sampling became exhaustive, corresponding to more than 95% of all active aquaculture producers that met the CAST criteria (see [Table 1](#)). We therefore consider this approach being close to a census, and highly representative of the entire commercial aquaculture population in the treatment and control provinces. A similar approach was followed for the survey of other actors in the value chain to ensure the target sample size was reached.

Despite the efforts of the survey teams, MFIs and some fish collectors and feed distributors in urban and peri-urban areas refused the survey, thus limiting the sample size in these actor categories.

2.1.7. Quality control and data cleaning

WorldFish researchers rotated and oversaw the training and survey implementation. In total, two field Researchers and one Aquaculture Expert oversaw the data collection in the field. For quality control, supervisors kept fieldwork control sheets to record contact with farmers and value chain actors, and GPS data for each farm surveyed, or GPS village points, in the case interviews could not be conducted on farm premises.

Supervisors conducted spot checks of at least 15% of all interviews. As a part of the quality control process, supervisors verified that (1) the interview took place, (2) the approximate duration of the interview, (3) the information was accurate, (4) the various sections of the questionnaires were administered properly, and (5) interviewers' adhered to professional standards. On a rotation basis, supervisors participated in the interview process along with the interviewer, intervening if any mistakes were observed. In addition, if verification of the interviews showed abnormal values¹³, supervisor contacted the respondent to validate the data. Using a digital version of the questionnaire allowed data validation at point of input, through setting criteria limits for each field, thus limiting recording errors. In each team, the supervisor conducted field editing of the questionnaires as required before data was uploaded daily to Kobo ToolBox server and the dataset was then exported into STATA 14 software for cleaning and analysis.

Completed questionnaires were checked and cleared by the team supervisor and forwarded to the central data entry office in Phnom Penh. Once per week during data collection, a review of the data was performed by Nuppun to identify inconsistencies and data capture problems. WorldFish and Nuppun conducted a quality control review of the raw data when half of the data were collected to ensure that the data were complete and accurate, and to determine if there were any problems with data conversion or the database structure. WorldFish and Nuppun developed a data cleaning protocol to check for inconsistency or abnormal responses and to generate the cleaned dataset. Extreme data values due to exaggeration or omission were double checked with enumerators and interviewees by phone interview and corrected accordingly.

2.1.8. Data analysis and indicators

Nuppun Research and Consulting performed data analysis to calculate the selected standard and custom indicators, using the STATA statistical package (version 14). The tables in Annex D present a tabular summary of FFPr and program-specific indicators, confidence intervals, and standard errors. Performance indicators regarding "improved management" of

¹³ Specific focus on value of section G of the questionnaire was required to ensure correct production data was capture.

farms and businesses¹⁴ were constructed based on several sub-indicators, reflecting an array of technology and practices. The sub-indicators include: “improved aquaculture technology and practices”, “marketing practices”, “post-harvest practices and technology”, and “other improved technology” (including business management)¹⁵. A firm or a farm was considered to be following “improved management practices”, only if the management follows at least 50% ($\pm 10\%$) of improved aquaculture technology and practices and 80% ($\pm 10\%$) of marketing, post-harvest and other improved technology and practices. Those thresholds were set up to reflect common improved management practices. For example, the sub-indicator “improved aquaculture technology and practices” is composed of a list of 15 aquaculture management practices.

Missing data were excluded from calculation in both numerator and denominator. “Don’t know” responses were considered as answers and counted separately. For the calculation of the indicators, “don’t know” responses were considered as a missing value.

For spatial analysis, the team used ArcGIS software to identify clusters of farmers within a 5 km radius to each other, using the GPS coordinate of the interviewed farms. Thus, the identified clusters include aquaculture farms within a 5 km radius.

Using the same tools and data, we included the location of the top 15 producers in each province (in terms of annual aquaculture volume produce per year) and location of hatcheries and nurseries to capture the geographical location of the farmer clusters and the source of fingerlings.

Analysis of other situational analysis variables was completed in Excel 2016 or STATA 14. These included aquaculture production system related variables (yield, stocking density, production) disaggregated for the main aquaculture species, and province. Variables related to performance of hatcheries, nurseries, feed distributors and post-harvest respondents were also disaggregated by species or product. Analysis included frequency of response in treatment and control provinces. In addition, qualitative information collected during the scoping exercise concerning main processing hubs and aquaculture fish wholesaler market was added to the analysis.

2.1.9. Covariate and propensity score matching (PSM)

We performed covariate analysis using R software, and tested the influence of key covariates on a selected number of variables. This covariate analysis explores which factors may affect outcomes from future projects.

Selected covariates include: province of farm or business; age and gender of farm or business owner; participation in a past project; receipt of loans; and for producers, the type of production (cage or pond). Control and treatment groups were tested for the confounder analysis. The effect of covariates were tested on the following variables: sales volume; sales value; yield; frequency of pellet feed; top fish species (in terms of volumes produced for hatcheries, nurseries, and producers; markets for collectors and wholesalers; processed products for processors); and the most frequently-reported type of management practice or technology (for aquaculture management and post-harvest/business/market practices). For the variable of yield, cage and pond producers were treated as separate populations rather than a covariate. This is due to the substantial difference in yield between cage and pond production systems. The covariate analysis used descriptive measures (frequencies and

¹⁴ Corresponding to Standard indicators #2; #3; #4; and custom indicators Custom #2; #3; #11. See Annexes D for definitions of the indicators.

¹⁵ Those sub-indicators are based on the disaggregation level of Standard indicators #3 and #4 indicated in the USDA Indicators and Definitions Handbook February 2019

means as appropriate) and variance measures (standard deviation and chi-squared tests as appropriate).

Our plan for data analysis sets the stage for the use of the Difference-in-Difference methods. However, baseline data alone is not sufficient to carry out this analysis. To prepare the final evaluation we conducted a propensity score matching (PSM) analysis in order to match individuals from control groups with producers from treatment groups for the future evaluation process. PSM uses observed characteristics to construct a statistical comparison group that is based on a model of the probability of participating in the program intervention. We conducted PSM for the aquaculture producer group only because of the insufficient sample size for other value chain actors. To be statistically significant, the minimum sample size of the control group should be at least 30 while that of treatment should be double. Considering the sampling framework ([Table 2](#)), we could only perform PSM on the aquaculture producer group.

After matching, it is expected that there will be no significant differences in characteristics (control variables) between treatment and control groups. To assess the matching quality, we checked the standardized bias of each independent variable in the logistic regression before and after matching. A standardized mean bias below 3% or 5% after matching is sufficient.

A priori, we used 11 variables¹⁶ to conduct the PSM. This analysis was performed under STATA 14, using the `psmatch2` command and included the following three main steps: (i) checking the goodness-of-fit of the model; (ii) checking balancing property using the `pscore` command; and (iii) conducting the `pstest`.

2.2. Methods for the qualitative study

2.2.1. Objectives and topical focus area

The purpose of this research is first to learn more about the aquaculture industry in Cambodia, what are the facilitators and barriers to future project implementation, and to identify constraints and opportunities to build relationships between actors along the value chain.

The study covers the three topics described in

¹⁶ 1. Age of proprietor; 2. Sex of proprietor; 3. Total number of household laborers involved in aquaculture; 4. Total number of full time and part time employees; 5. Total area (m²) of grow-out ponds; 6. Total volume (m³) of grow-out cages; 7. Main source of water; 8. Number of pumps owned; 9. Operate a feed cooker; 10. Number of production cycles in 2018; 11. Number of species stocked in 2018.

Table 5, developed in collaboration with CAST, and discussed with an array of stakeholders involved in the aquaculture value chain. The content of

Table 5 guided the development of several interview guides that varied according to the audience. The English version of the interview guides are found in **ANNEX C: QUESTIONNAIRES & SURVEY TOOLS**.

Table 5: Key topics covered during the interviews and audience

Key Topics	Additional Information
Aquaculture Industry <u>Areas of interest:</u> - Commercialization of the aquaculture sector - Traceability and quality control system for aquaculture products	<u>Purpose:</u> Better understand the constraints and opportunities to development of a commercial aquaculture sector and specifically a traceability and quality control system at the sector level. <u>Audience:</u> Development partners, HORECA, Government, MFI
Program Implementation <u>Areas of interest:</u> - Barriers and facilitators to program implementation - Services and support needed for beneficiaries' success - Awareness of and participation in other aquaculture support programs	<u>Purpose:</u> Better understand the barriers and facilitators to deploy the project on the ground, reach beneficiaries and provide appropriate support in terms of content and format. Understand where CAST is placed compare to aquaculture project. <u>Audience:</u> CAST partners, project potential beneficiaries* (Development partners, Government will be asked about Awareness area of interest, only)
Relationship Building <u>Areas of interest:</u> Current and future communication between market actors	<u>Purpose:</u> Better understand the gaps and needs in terms of communication between actors of the value chain and access to knowledge for specific actors of the value chain <u>Audience:</u> Project potential beneficiaries; HORECA, MFI

2.2.2. Study participants, interviewing and data collection

The qualitative study covered more actors in the sector than the population-based survey, including CAST project partners, Government representative, development partners and fish retailers, in addition to project potential beneficiaries.

WorldFish and CAST selected a total of 46 Key Informants (**ANNEX E: LIST OF KEY INFORMANTS**). Criteria for selection included their level of interest toward CAST activities and their role and importance in the value chain. The scoping exercise performed by WorldFish (see Section 2.1.3 **Error! Reference source not found.**) identified some key actors of the value chain (hatcheries, nurseries, wholesalers, collectors, processors). These actors were selected for KII, based on their volume of operation and reputation. For feed distributors, Agri-Master, a feed company that will be a key partner of CAST, provided us a list of their feed distributors to interview. Government agency representatives, development partners and donors, were identified within the members of Technical Working Group Technical Working Group on Fisheries.

WorldFish implemented the qualitative study. Three staff conducted the interviews from June 3rd-30th, 2019. The interviewers contacted the key informants in advance, either by e-mail or by phone to make appointments, inform them about the study, and give details about the purpose and topics to be covered during the interview. Interviews lasted 30 - 45 minutes, and were recorded with an audio recorder. In case audio recording was not accepted by the interviewee, the interviewer took notes, following the "free-listing method" (provided by CAST team) and generated an interview report. Audio recordings in Khmer were sent for transcription in Khmer, and later translated in English.

2.2.3. Data preparation, coding and analysis

During the transcription and translation phases, the interviewer verified the accuracy of both the transcription and translation. Transcription/translation proceeded from June 4 until July 30. Following feedback from several interviews, the WorldFish team established a coding protocol, including a code book, to code each transcript. Protocol for coding and analysis was

developed in collaboration with CAST team. WorldFish's lead consultant and two field researchers coded the 46 transcripts. After coding was completed, the team produced node reports that were further analyzed to identify emerging themes, and report frequency and extensiveness, using the functions available in NVivo.

2.3. Limitation of the data collected

The baseline study faced several challenges during its design and implementation, and thus the resulting data have limitations.

Complexity of questionnaire

The population-based survey required respondents to provide detailed information on multiple aspects of their farm activities. The quantitative questionnaire's complexity made interviews difficult, and affected the data accuracy. Respondents became tired and distracted toward the end of the interview and needed extra coaxing to complete the survey.

Inaccuracy of key secondary sources of information

The list of existing aquaculture farmers, compiled from national/sub-national government authorities during the scoping exercise, and used for survey sampling frame, was found to be outdated during the field missions. Despite triangulation and regular communication with local government authorities, we were not able to verify the accuracy and quality of information for all the villages, in advance of the survey. Additional scoping was needed in communes to find additional fish farmers and modified the sampling framework (see Section 2.1.4).

Accessibility and language issues

Interviewing fish producers from ethnic minority groups (corresponding to about 5% of the sample) was constrained by language barriers, as the enumerators did not speak Vietnamese. Interviewing cage farmers that migrate along the river on the Tonle Sap Lake created additional challenges. Some stakeholders in the value chain declined to participate in the survey. While producers and hatcheries were willing to participate in the survey, traders had less time to answer the questions. This was particularly the case in Kandal and Phnom Penh Provinces. These constraints resulted in replacing respondents and delayed data collection.

Validity and reliability of self-reported data

Most data collected for the farm survey are self-reported by the respondents. This has several limitations, such as the possibility of exaggeration or omission of information, inaccurate recollection of experiences or events, social-desirability bias, or reporting of untruthful information and reduced validity when respondents do not fully understand a question. This issue was limited by training the enumerators about aquaculture practices, and acceptable ranges of responses. Extreme values were verified during data cleaning, and discarded, if necessary, during data analysis.

Small sample sizes for certain categories of respondents

The sample size for certain categories of actors, such as feed mills, MFIs or feed distributors is small, compared to the sample considered for producers. Thus, the analyses for these specific small groups should be interpreted with caution as the small sample sizes may yield unreliable estimates and limit the validity of differences observed.

3. BASELINE RESEARCH QUESTIONS

This section provides baseline information in response to the CAST research questions. The original research questions, meant for impact evaluation at the end of the project, have been rephrased here to establish the baseline conditions for the purpose of the current study.

3.1. What is the current productivity of feed mills, aquaculture producers and hatcheries and nurseries?

The average yield of aquaculture is 4.77 kg/m²/year in pond and 44.00 kg/m³/year in cage, considered very low productivity (Standard indicator #1). The range for both production systems varies widely due to differences in production intensity. *Pangasius*¹⁷ culture in pond and cage for example, produced 6.7 kg/m² and 31 kg/m³ respectively, achieving significantly lower levels of production intensity, compared to similar production systems in Vietnam, with 27.5 kg/m²/year and 100 to 120 kg/m³/year¹⁸ in pond and cage, respectively. Cage and pond production systems with giant snakehead are the most productive (65 kg/m³/year in cage and 7.2 kg/m²/year in ponds) (Figure 2). Results are within the same range in control provinces, with giant snakehead reaching a productivity of 9.2 kg/m² in ponds and 49 kg/m³ for *Pangasius* produced in cage and average yield of 2.11 kg/m² and 32 kg/m³ in pond and cages, respectively (Figure 2).

Hatcheries produce on average 1.2 million fingerlings, annually. Among the 17 hatcheries surveyed in treatment provinces, there was wide variation observed in hatchery performance, with 11 hatcheries producing less than 0.3 million fingerlings, while four hatcheries recorded more than three million. The number of fingerlings traded by eight nurseries surveyed in treatment provinces, is about two times larger than the number of fingerlings produced by all 17 hatcheries surveyed in the same provinces. A similar pattern is observed in control provinces, with an average hatchery production of 431,000 fingerlings per year. Only one of the 13 hatcheries interviewed in control provinces produce more than one million fingerlings per year. Hatcheries in Vietnam are the main source of fingerlings in Cambodia in both control and treatment provinces. No feed mill produced aquaculture feed in Cambodia in 2018.

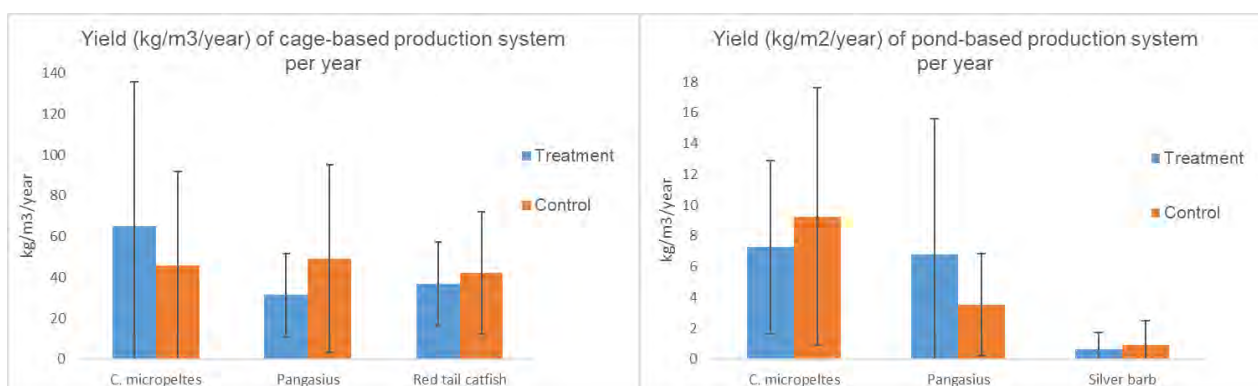


Figure 2: Yield of cage (left) and pond-based (right) aquaculture systems in treatment and control provinces

3.2. What is the current soy protein and fish product trade in Cambodia?

Thirteen thousand MT of fisheries product was reportedly exported in 2017, of which 8,500 MT was fresh fish (sold alive, trash fish and dead on ice) and 4,500 MT was processed fish¹⁹

¹⁷ In this report *Pangasius* refers to the main cultivated species of *Pangasius* in Cambodia: *Pangasius hypophthalmus*

¹⁸ http://www.fao.org/fishery/culturedspecies/Pangasius_hypophthalmus/en

¹⁹ More than 50% of the processed fish product in Cambodia are prahok (fish paste) and dry fish, representing an annual production of 30,000 MT and 18,000 MT respectively

(FiA 2017). Major export destinations were Thailand and Vietnam for both fresh and processed products. Disaggregated data on source are not available, but recent literature indicates capture fisheries²⁰ as the main source of export products (e.g., fermented fish paste called *prahoc*) (VCA4D, 2018; Kusakabe, 2016).

Soybean production in Cambodia increased from 40,758 MT in 2016 to 91,729 MT in 2018 (MAFF 2018). Fueled by the animal feed market demand, the volume of soybean imported from the U.S. to Cambodia reached 51,000 MT in 2017 (composed of soy cake and meals), corresponding to a value of US\$19 million (see **ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table A). None of the feed mills interviewed reported U.S.²¹ as the main source of soymeal for their animal feed ingredient. As of 2018, there is no indication that the aquaculture sector has any significant influence on the trade of soybeans in Cambodia.

3.3. What is the current quantity and quality of feed and seed produced for aquaculture producers and its availability and accessibility?

The study found only one feed mill starting aquaculture feed production in Cambodia, but this is yet to reach commercialization. This feed mill plans to comply with international quality standards²². Therefore, all manufactured aquaculture pellet feed sold in Cambodia is currently being imported. The 17 feed distributors surveyed each sell on average 1 to 4 brands of feed, and 92% of feed distributors report that at least one of the products sold meet at least one international standard. The average volume sold by the surveyed distributors during the peak growing season is 23.4 MT, varying from 1.5 MT to 54 MT per distributor.

Approximately 20.3 million fingerlings are produced annually in the treatment provinces (5.5 million in control provinces). There is no quality certification²³, even though some producers claim their fingerlings are “certified”. Similarly, imported fingerlings are not certified. Tilapia and *Pangasius* are the main species of fingerlings produced locally, representing 40% and 36% of the total volume produced in Cambodia (Figure 3). However more than 95% of the *Pangasius* production comes from one single hatchery. For nurseries, the dominant species are *Pangasius* (38%), *Clarias* (walking catfish) (38%) and giant snakehead (19%). Average price of fingerlings is US 2.4 cents per individual for *Pangasius* in hatcheries, and US 2 cents in nurseries. For similar species, the price can be 20 – 60% lower in nurseries. Product destination is within the province (76%) or other provinces (23%). Aquaculture producers usually source their fingerlings from fingerling traders or nurseries (78%).

Nurseries are central to fingerling provision to farmers. We selected only licensed nurseries, however, unlicensed nurseries probably contribute to large imports of snakehead and giant snakehead in the country. In addition, unlicensed nurseries of wild fingerlings exist but were not included in the sample.

²⁰ We define capture fishery as the harvesting of naturally occurring living resources in both marine and freshwater environments. It is opposed to aquaculture systems that are broadly defined as Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants (FAO, <http://www.fao.org/3/x6941e/x6941e04.htm>)

²¹ Note that most of the soymeal imported to Vietnam is sourced from Argentina (WISHH 2016).

²² ISO 9001: Quality management; ISO 14001: Environment System Certification; ISO 22000: Food safety management; HACCP Hazard Analysis and Critical Control Points; Best Aquaculture Practices; Global G.A.P. standard

²³ Quality certification for fingerlings can include specific strain (genetic material), absence of parasite or disease

As mentioned above, no Cambodian hatcheries or nurseries supply certified seed, and no feed mills produce feed of international standard, resulting in a null score for Custom #3 indicator (i.e. number of hatcheries and feed mills that are supplying seed or feed that meets improved quality standards) in both control and treatment provinces.

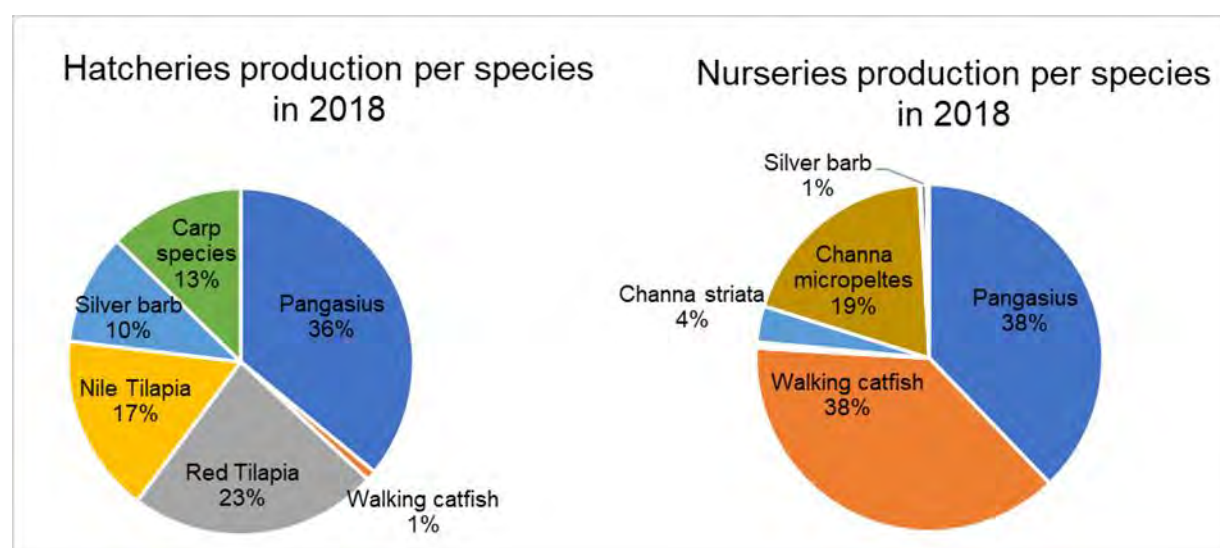


Figure 3: Relative volume of fingerlings species sold by hatcheries and nurseries in 2018

3.4. What is the current supply of premium quality, Cambodian-grown freshwater fish to the local market?

On average, commercial aquaculture producers in treatment provinces sold 8.7 MT of fish per year, dominated by *Pangasius hypophthalmus* (river catfish) (59%) and *Channa micropeltes* (giant snakehead) (23%). Total volume sold by surveyed farms in treatment provinces was 7,941 MT (Standard #19) (**Figure 4**). Although the average sales volume was lower in control provinces (4.1 MT of fish per year per farmer), the top species were similar to treatment provinces, with *Pangasius* and giant snakehead representing 40% and 33% of the volume produced. In the treatment group, the top producing provinces are Phnom Penh (33%), Pursat (13%) and Battambang (24%) (**ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table E). Kampong Chhang Province represents 77% of the volume produced of the three control provinces, followed by Takeo (16%) and Banteay Meanchey (7%).

Snakehead (*Channa striata*) and giant snakehead are ranked as the most traded aquaculture products, in terms of volume, for collectors, wholesaler and processors. In post-harvest segments of the value chain, the total volume of fish purchased per year by collectors, wholesalers and processors combined is 16,334 MT, of which 54% and 69% comes from Cambodian aquaculture for collector and wholesalers, and processors, respectively.

The most important processed products are dry fish and smoked fish, representing the majority of the 713 MT sold annually by processors, in the treatment provinces. The top aquaculture species traded by post-harvest respondents are snakehead and walking catfish, for collectors and wholesalers, and giant snakehead and snakehead for processors.

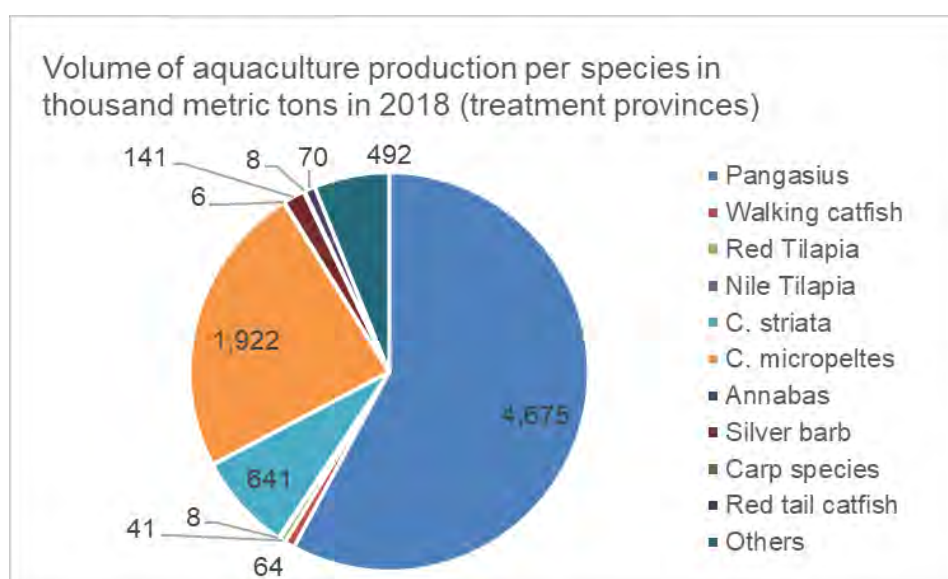


Figure 4: Distribution per species of 2018 aquaculture production in the treatment provinces

The quality and hygiene standard compliance in the sector is low, with no producers or post-harvest actors (collectors, wholesalers, processors) following any recognized standard hygiene procedure in both treatment and control provinces. However, the average quality of the Cambodian aquaculture fish purchased by post-harvest respondents is considered as good or very good in 70% of the cases, and the average spoilage rate is estimated to be below 5%.

3.5. What is the current potential beneficiaries' ability to access finance that is needed for business growth and development?

Within the treatment provinces, 48% of all the respondents had loans, either in cash or in kind. This percentage reduced to 33% in the control provinces (Annex F, Table C). Fish producers are the category of respondents with the highest percentage of loans (51% in treatment group). The majority of loans obtained are for cash and limited numbers of reported loans are in-kind in both treatment and control group. Farmers take out loans to finance inputs (fingerlings and feed), while post-harvest respondents use loans to invest in equipment or warehousing (Annex F, Table B and C).

The occurrence of loans is lower in the control provinces, with 25% of wholesalers and 33% of producers taking loans. These data are self-reported, and include not only the formal loans contracted from banks or micro-finance institutions, but also money borrowed from informal money lenders. Twenty-four percent of farmers in the treatment group claimed to have loans from MFIs, with an average size of \$9,375. In the control group 18% of the producers had loans with MFIs, with an average size of \$2,459.

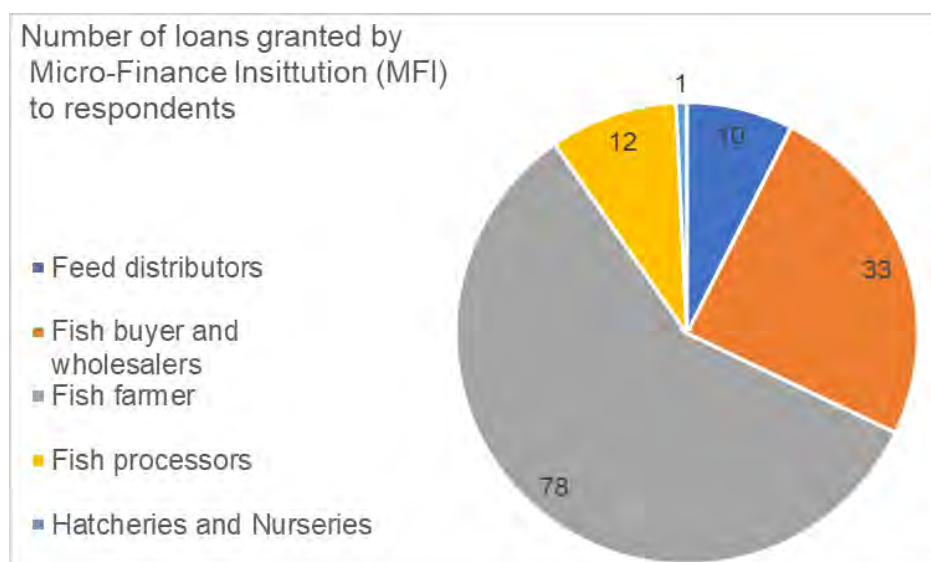


Figure 5: Distribution of loans granted by MFI to the different types of respondents (treatment group)

On the other hand, the eleven MFIs interviewed in treatment provinces reported on average only 12 loans disbursed to aquaculture value chain actors. In treatment provinces, the average size of these loans was \$26,375, with very high variability ($\pm \$25,250$). In control provinces, the average loan size is larger ($\$84,250 \pm \$82,699$), but based on a smaller sample size. Fish producers contract 58% of these loans (*Figure 5*) and again for very variable amounts ($\$32,000 \pm \$30,250$, *Figure 6*). Interest rates provided by MFIs are high (13% per year). The qualitative study reports the limited knowledge of MFIs about the aquaculture sector, and the absence of tools and infrastructure to help producers and post-harvest actors to apply for formal loans. Also, several interviewees reported that loans from fish collectors and wholesalers constrain access to higher market prices for fish producers. Fish producers have to sell their production at prices decided by the buyers, who are also providing the loans.

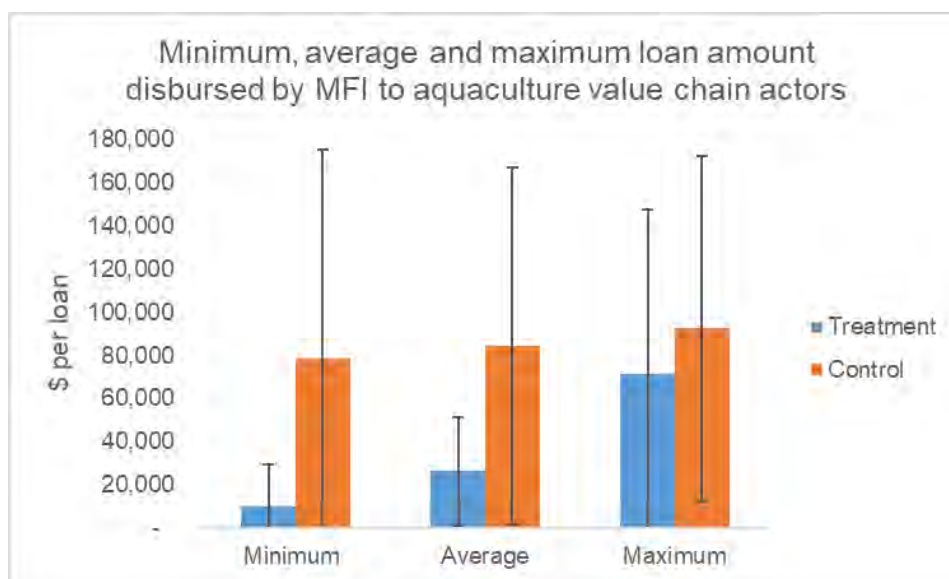


Figure 6: Loan amount disbursed by MFI to aquaculture value chain actor in 2018 in control and treatment provinces.

3.6. Where are clusters of active SME farms and hatcheries that meet the selection criteria as potential beneficiaries of CAST?

Spatial analysis within the treatment provinces identified 50 clusters of producers that are separated from each other by more than five kilometers (see Figure 19). Those clusters vary in size, from three producers to more than 80 producers. Largest clusters are found in floating villages around the Tonle Sap. In all treatment provinces a nursery or hatchery is operating and providing access to fingerlings, however producers do not necessarily purchase fingerlings from hatcheries or nurseries in the same province. The presence of nursery importing fingerlings of snakehead, giant snakehead and Pangasius is required to operate commercial aquaculture clusters. Additional details regarding cluster and spatial distribution of aquaculture cluster is found in section 4.9.

3.7. Where are existing value chain networks at provincial level that can be strengthened to meet CAST objectives?

We identified seven major wholesale fish markets (locally called “landing sites”) where aquaculture fish are traded (see Table 8 in section 4.9). Those landing sites are located in Siem Reap, Kampong Cham, Pursat, Battambang Provinces and Phnom Penh. In these landing sites, not only Cambodian aquaculture produced fish is traded, but imported fish and fish from capture fisheries are found. However, those landing sites are key “hubs” where fish is later redistributed within the country.

In addition to the landing sites, 12 “processing hubs” are identified in seven provinces (see Table 9 in section 4.9). Processing hubs are concerned with dry fish, fermented fish and smoke fish. We did not find any semi-industrial fish processing hub. Additional details are found in section 4.9.

3.8. Who and where are existing or potential extension service agents that can become core facilitators of value chain networks?

Aquaculture extension is weak in Cambodia (Richardson et al. 2017). Fisheries Cantonment officers are not the main source of training and information about aquaculture

product. We found that feed manufacturers can provide technical support to feed distributors (in 41% of the cases). Feed distributors mostly support farmers with technical advice at the shop, but also with technicians supporting farmers directly, with 13 producers supported by one feed distributor, on average. The scoping exercise found an example (in Kampong Cham Province) of a hatchery working in collaboration with a feed distributor to sell their product and advice. This type of collaboration helps to build trust with farmers who can witness farm operations.

3.9. What are the constraints and opportunities within various segments of the commercial aquaculture value chain in Cambodia?

Constraints and opportunities along the various segment of the value chain are analyzed in detail in Section 4. We found that access to inputs (fingerlings and manufactured feed) is limited due to high prices. Production of fingerlings of the main commercial species is low or absent and the sector, as for manufactured feed, depends on imports from Vietnam. Quality and source of the imported fingerlings is unknown and current aquaculture management practices are low, explaining, at least partially, the low productivity observed in this study (see section 3.1). Access to training for aquaculture and post-harvest technique is limited and the source of information and knowledge are scarce (section 4.6.2). Post-harvest segments operate at limited level of improved management practices, with no standard sanitary and phyto-sanitary procedures.

Proportion of Cambodian aquaculture fish traded or transformed in the post-harvest segment can be high compared to imported fish. However, aquaculture fish is in most cases sold alive, and cold chain equipment is rarely found (section 4.5). No industrial or semi-industrial aquaculture fish processing are yet operating in the treatment provinces.

Despite those constraints, the qualitative study shows that there is a growing demand for Cambodian aquaculture fish, considered of higher quality than imported fish. Although producers face drought and flood, pond producers are equipped with flood protection fences, but access to water can remain problematic. Competitiveness of production system could be improved by providing access to affordable, non-imported, high quality pellet feed. Combination of lower input prices and optimal management of the pond and cages will improve economic competitiveness of aquaculture products on the local market.

4. SITUATION ANALYSIS

This section provides an overview of the commercial freshwater aquaculture sector in Cambodia based on the population-based survey results and scoping exercise.

4.1. Population characteristics

The majority of producers are male (96%), aged older than 29 years. Only 11% of aquaculture farm proprietors are female (

Table 6). Women proprietors are well represented in the post-harvest segment of the value chain. The average number of employees remains limited amongst all the respondents, except for feed mills and MFIs. Within our sample, the total number of longer-term employees at producer farms is 189 (0.2 on average), and majority are male older than 29 years. On-farm, short term employees are also predominantly male, with an average of two persons per year/farm, hired for an average of 7 days per year. Gender and age proportion were similar in the control population (see **ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table D).

Table 6: Characteristics of the surveyed population

	Producers	Hatcheries	Nurseries	Collectors	Wholesalers	Processors	Feed distributors	Feed mills	MFI
n	918	17	8	24	21	26	17	8	11
% of proprietor 15-29 years old	4	6	13	8	0	4	6	0	0
% of proprietor ≥30 years old	96	94	88	92	100	96	94	100	100
% of proprietor male	89	100	88	46	57	48	59	100	91
% of proprietor female	11	0	13	54	43	52	41	0	9
Average number of employees*	0.2	1.6	0.7	1.3	3.1	1.7	0.5	290	88
Total number of employees	189	28	6	32	66	43	9	2,317	967
% of employees ≥30 years old	98	100	100	97	100	100	89	-	-
% of employees male	88	100	50	16	47	56	33	-	-

Note: *Not including the proprietor and family members

Based on USDA Indicators and Definitions Handbook, our producer sample is composed of six ‘non-smallholder’²⁴ (> 5ha), with the remainder considered ‘smallholder’ (<5ha). For other respondents, “small-enterprise” accounted for only two hatcheries, while all input suppliers and post-harvest respondents are considered “micro-enterprises²⁵”. This classification does not take into account MFIs and feed mills.

4.2. Seasonality of production and sales

Aquaculture in Cambodia is characterized by strong seasonality. The main drivers explaining seasonality of aquaculture production are access to water during the dry season (November to May), rainy season (May to October) and peak season of capture fisheries in November to February (the main source of fish to the local market).

The peak harvesting and selling period of aquaculture is in April/May for pond production, and in March for cage production. For both, stocking period is concentrated between June and August (Figure 7). The peak periods for hatcheries and nurseries are different. Hatcheries peak corresponds to the peak demand for farmers, while nurseries seem to operate all year round. Only 45% of hatcheries are able to meet the demand during the peak stocking period. The interview results from feed distributors indicate uncertainty about feed demand trends over the past 5 years, with 33% reporting increasing demand, 25% indicating stable demand, and 38% reporting a decline. . For feed distributors, the peak selling period was May-July for 50% of the sample, and extended until December for 40% of sample. Feed distributors do not

²⁴Smallholder Definition: While country-specific definitions may vary, use the Feed the Future definition of a smallholder producer, which is one who holds 5 hectares or less of arable land or equivalent units of livestock (USDA Indicators and Definitions Handbook February 2019)

²⁵ Microenterprises employed <10 people in the previous 12 months, small enterprises employed 10-49 people, medium enterprises employed 50-249 individuals and large enterprises and corporations employed >250 individuals (USDA Indicators and Definitions Handbook February 2019)

distinguish a clear end of the peak season, and responses varied according to each situation. Average volume sold per shop during this peak period varied across our sample from 1.5 to 91 MT (average of 18 MT) (Figure 8). In the control group, the amount sold during the same period varies from 5 to 45 MT (average of 13 MT). Seasonality is similar in the producer control group, with a peak harvest from April to May, while hatcheries peak selling season is from August to October.

Post-harvest segments of the value chain have a peak period of activity from November/December to April, corresponding to an overall increase of activity in the fisheries industry in Cambodia, and not specifically for aquaculture. On average, the shortage of aquaculture fish lasts 3 months starting from April/July to August/October, depending on the season. Processors have a peak period later in the year April to July. In the control group, the peak for collectors and wholesalers is similar, but processors report a shorter peak season from November to December.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Processors												
Collectors/ Wholesalers												
Feed Dis.												
Nurseries												
Hatcheries												
Pond farmers												
Cage farmers												

Figure 7 : Production calendar and selling period for different actors of the aquaculture value chain (S: stocking fingerlings; H: Harvesting fish)

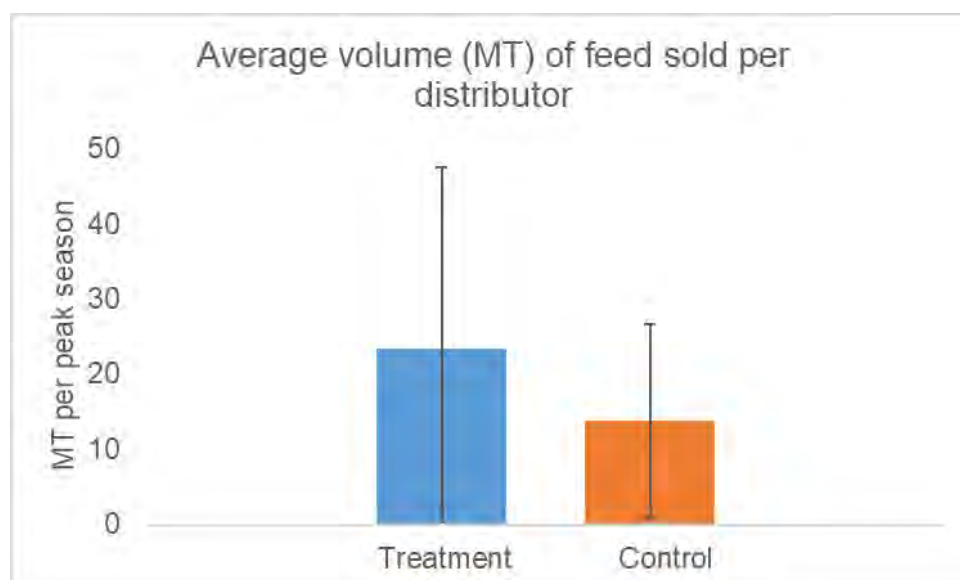


Figure 8: Average amount of feed sold by feed distributors during 2018 peak season in treatment (n=15) and control (n=7) groups

4.3. Hatcheries and nurseries production systems

The average hatchery operates with 12 ponds (average surface area of 744 m²), including four to five ponds for broodfish. Most hatcheries also have grow-out ponds to raise fish. On average, a hatchery owns 5.5 tanks for spawning and hatching. All hatcheries and nurseries own at least one pump. Seven hatcheries (41% of the sample) and four nurseries (50% of the sample) are equipped with a well, of which two rank groundwater as the main source of water for their operations. In these two cases the average well depth is 16 m. Fifty-two percent consider river and stream as their main source of water in treatment provinces, while 84% of the hatcheries in control provinces are rainfed. However, in control provinces, 76% and 100% of the hatcheries and nurseries are equipped with a well. Overall, hatcheries are not all well-equipped, with only 76% of the hatcheries having an oxygen tank, 18% equipped with larval rearing cones and only 12% with a refrigerator to keep hormones (for production of mono-sex tilapia).

Hatcheries in control provinces are overall better equipped than in treatment provinces, with 100% of hatcheries equipped with oxygen tank and 23% using a refrigerator to store hormones, for example. The average hatchery in the treatment group produces two to three species, and three to four species for the control group. Nurseries trade between one and nine species. Locally, the most frequent species produced are tilapia (both Nile and red), and silver barb and carp. A similar pattern is found in the control group, but with more frequent *Pangasius* and walking catfish production. In the treatment group only four hatcheries produced *Pangasius* fingerlings (7.3 million per year in total), while six control group hatcheries produce 2.1 million *Pangasius* fingerlings.

Fingerlings of the most important species (by volume) (e.g., snakehead), are imported from Vietnam, due to better supply security (Figure 9). In total, the 17 hatcheries in treatment provinces sold 23.3 million fingerlings while 5.5 million were sold in the 13 hatcheries surveyed in control provinces.

Only 37% of the hatcheries interviewed follow any recommendations from past projects and extension services. Further, the hatchery sample implemented only 4.17 of 12 different common best management practices, prompted in the interviews. A similar pattern is found in the control group, with in average 3.58 best management practices adopted. No hatcheries produce fingerlings to international standards.

More than 82% of hatcheries quarantine their brood-fish (92% in control group), but only 41% do parasite checks (16% in control group), or follow proper hygiene practices. In both hatcheries and nurseries, fingerlings size was small (7 cm or 3.5 g). In addition, proper grading is done only in 14% of nurseries and hatcheries (14% in control group). Hatcheries generally sell within the province (75% of respondents), directly to farmers (average of eight farmers) or traders (average of five traders) and nurseries (average of three nurseries).

Average survival rate during nursing is low, (46% in treatment and 56% in control groups) and could be improved. Reported mortality rates are low (2 percent on average), but average time/distance between hatcheries and nurseries is significant (5 to 6 hours), indicating a need for improved transportation practices and technologies, and for better organization between local hatcheries and nurseries and producers. Handling practices and transport in both hatcheries and nursery can be improved. Transport in plastic bags without oxygen is relatively common (36% of cases) with an average 22 hours stopped-feeding before transport, which for the latter corresponds to recommended practice. On average, nursing of fingerlings lasts for a period of 27 and 30 days for treatment and control provinces, respectively.

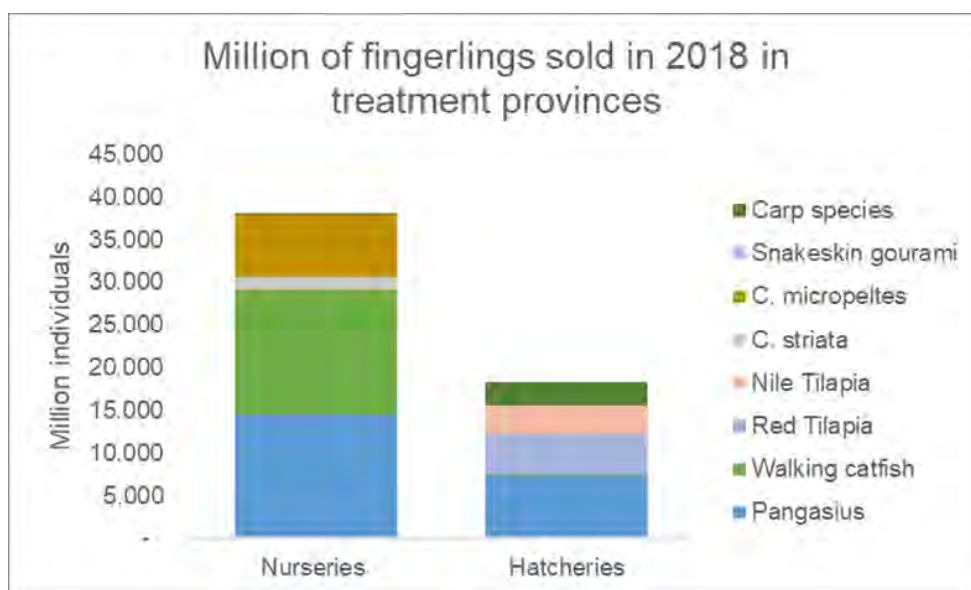


Figure 9: Number of fingerlings sold by hatcheries and nurseries in treatment provinces in 2018 (see ANNEX F: **ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table I)

4.4. Fish farm production systems

Producers operate an average 1.6 ponds and 1.4 cages. The median area of pond is 625 m² and 45m³ for cages. The average pond size is skewed due to a few very large farms (> 6 ha of ponds). Large-scale producers represent 29% of the ponds and only 11% of the cages (Figure 10). Similar distribution is found in the control group. The dominance of large-scale farms validates our sampling approach to target commercial farms. However, overall, production surface area and volume is limited (median of 625 m²). This clearly illustrates the limited number of larger size aquaculture business units currently operating in Cambodia. We found differences in distribution of farm size across provinces. For example, Phnom Penh municipality has a large proportion of large scale cages (89% of the cage farm surveyed in that administrative unit), while small-scale cage farms are dominant in Pursat (65% of cage farm surveyed are small-scale) and Siem Reap (58% of the cage farm surveyed are small-scale). Large scale pond-based farms are dominant in Phnom Penh municipality, Pursat , Battambang and Kampong Cham Provinces, representing 92%, 63%, 60% and 54% of the farm surveyed, respectively.

In the control group, Takeo Province has a homogenous distribution of pond-based farms across the three categories, while large scale pond-based farms are dominant in Banteay Meanchey (65%), while in Kampong Chhnang large scale pond and cage based farms are dominant. Detailed distribution of farm size per province is found in **ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table R.

Seventeen percent of the pond-based farms are rainfed, with river and stream identified as the main water sources. Thirty-two percent of farmers have a well (average depth 22 meters), but only 10% consider groundwater as the main source of water for their ponds. Highest concentrations of wells are found in Kandal and Kampong Cham Provinces. The control provinces have a lower proportion of aquaculture farms equipped with wells (**ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table O). Sixty-three percent of producers own, and ten percent rent, one or two pumps and only four percent of ponds and cages are equipped with aerators.

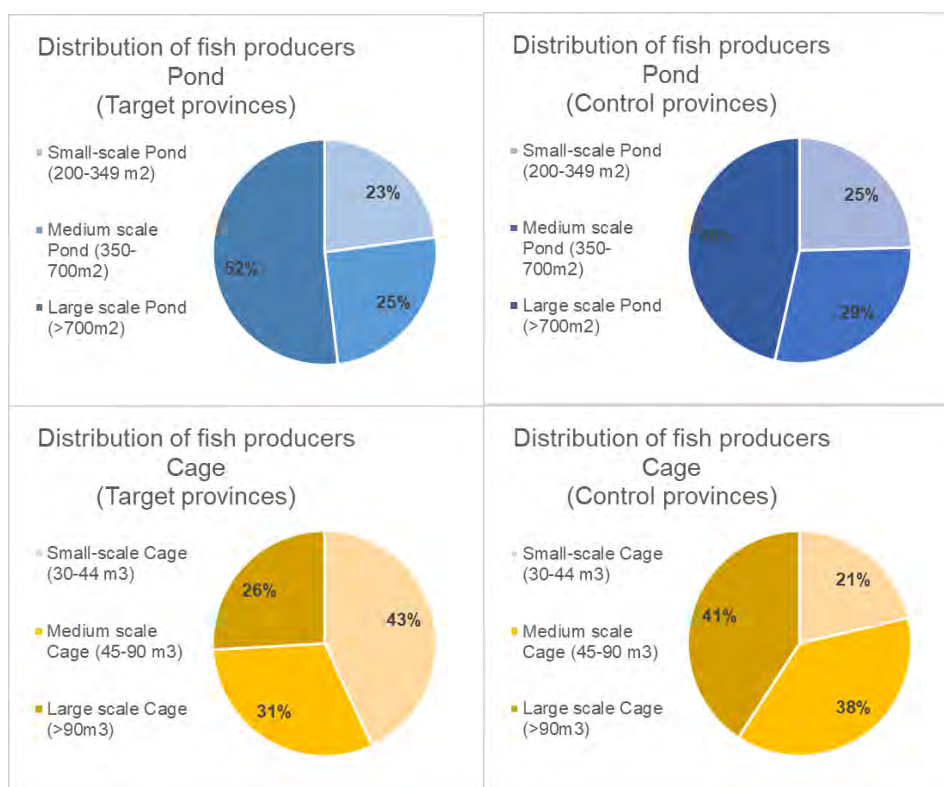


Figure 10: Distribution of pond and cage fish farm by class size in control and treatment provinces

The average producer currently operates at sub-optimal levels, implementing only three out of 15 improved practices prompted during the interviews (**ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table G). Basic aquaculture practices, such as using lime and fertilizer or controlling predators, are not common. Water quality monitoring is practiced by less than 10% of producers. Stocking density of snakehead and giant snakehead in ponds and cages are high, leading to high mortality rates and reduced economic results (Figure 11).

We found that feeding practices vary between provinces (Figure 11: Average stocking density in ponds (fish/m²) and cages (fish/m³) of the three most common aquaculture species

Figure 12). Trash fish feeding is only dominant in Kandal, Kampong Thom, and Siem Reap Provinces, while other provinces use a combination of mixed feed. We hypothesize that the dominance of trash-fish as fish feed in those provinces is due to the production of giant snakehead and the proximity of fish landing sites. According to key informant interviews, seasonality of trash fish price explains the feeding regime choice, with low trash fish price during the peak fishing season (December to March). During the closed season, trash fish price will increase, making pellet feed price more competitive.

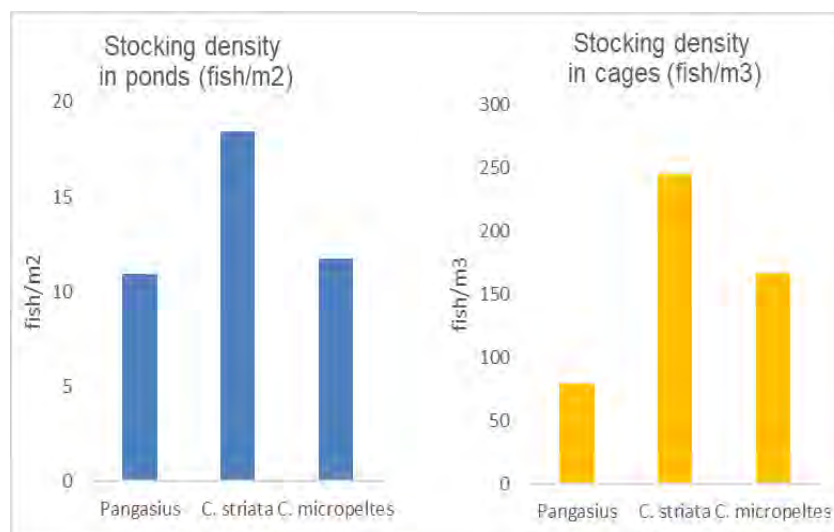


Figure 11: Average stocking density in ponds (fish/m²) and cages (fish/m³) of the three most common aquaculture species

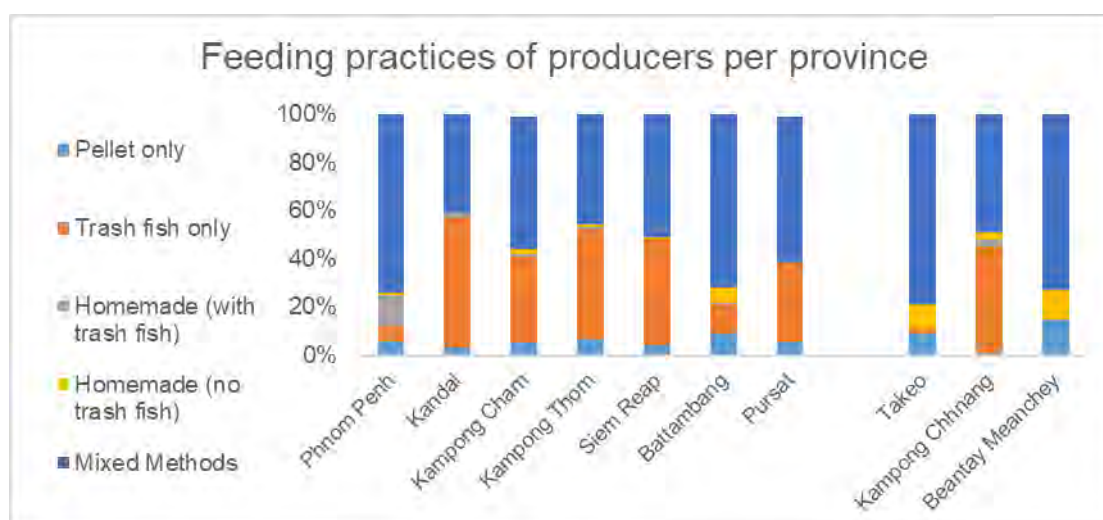


Figure 12: Feeding practices of producers in the different treatment and control provinces.

The majority of farmers use a combination of feed, with <10% of the farmers relying solely on pellet feed (varying between provinces) (Figure 12). Co-variate analysis shows that pellet-use frequency is higher in control provinces than in treatment provinces. In Takeo and Banteay Meanchey Provinces production systems are less oriented toward carnivorous fish, such as snakehead and giant snakehead, and therefore use less trash fish. In those provinces, carp and tilapia production system are more popular, thus pellet feed is more commonly used. In addition, access to loans and past involvement in aquaculture development projects, significantly increases the adoption and use by producers of pellet feed.

The number of production cycles per year varied between 0.84-1.23 for cages, and 0.7-1.4 for ponds (0.89 and 0.85 cycles in cage and pond, respectively, in the control group). Producers raising walking catfish may achieve three cycles in cages and ponds. Other common commercial fish (e.g., snakehead or *Pangasius*), have a longer grow-out stage, and a single cycle per year is normal. Cambodian aquaculture has a high market demand for fish

sold alive, requiring daily harvest. Otherwise, for all respondents, 32% record harvest intervals longer than 5 days, with 12% longer than 20 days. In general, longer harvest periods have detrimental impacts on fish quality, increasing stress and probability of diseases, and increasing feeding cost.

Only 13% of the producers received training in aquaculture techniques. Producers have the highest level of participation in previous development projects (e.g., FAIEX-JICA Phase 2 and USAID HARVEST in Siem Reap, Battambang and Pursat Provinces). Training received from past projects is not significantly correlated with volume, value or yield achieved by producers, although there is evidence that training has led to greater adoption of pellet feed and better pond management. Conversely, former project beneficiaries have significantly less contracts/agreements with buyers (**ANNEX G: COVARIATES ANALYSIS**).

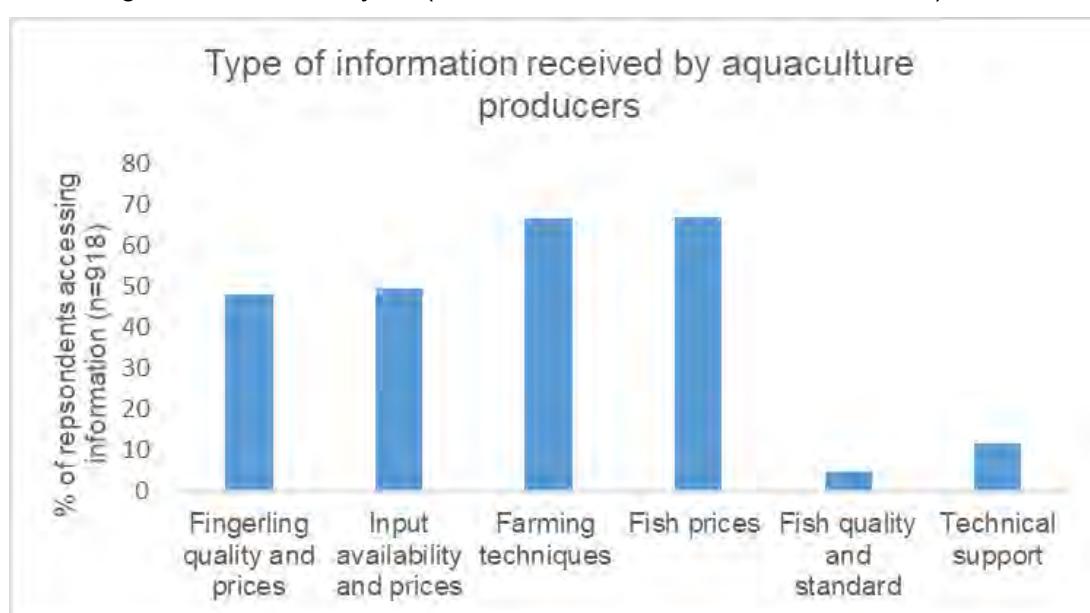


Figure 13: Type of information received by aquaculture producers

Access to information is the next feature to be analyzed. Access to market prices was rated as relatively high (67%), while information regarding inputs (fingerling and feed) was rated as average (50%). Access to information regarding techniques (11%) and quality standards (5%) was low amongst producers (**Figure 13**). The main sources of information for aquaculture techniques are development projects and Fisheries Administration, while for market and regulations (standards), the sources are fish buyers and development projects, respectively (**Annex F, Table M**). In control groups, access to market information was found to be similar, with 78% of producers, 75% of collectors, and 88% of processors, accessing this information. Hatcheries represent an outlier, with only 8% stating they access market information.

In summary, aquaculture production in Cambodia consists of both pond and cage systems. Feeding practices are often influenced by the location of farms and accessibility to trash fish, as well as availability of trash fish during the culture cycle. Training received from past projects in certain areas has had a positive influence on feeding practices. However, management of ponds and cages remains basic, with limited access to technology and high-quality inputs. Integration in the value chain for marketing is based on personal relationships and there are no quality standards being followed by producers.

4.5. Post-harvest (collectors, wholesalers and processors)

Collectors and wholesalers purchase fish directly from producers. Around 14% of wholesalers report they are also involved with processing. Processors purchase their fish from either collectors or directly from the producers' farms.

The aquaculture post-harvest segment is dominated by live fish trade, representing more than 80% of the volume traded by collectors and wholesalers. The respondents sourced more than 50% of their fish from Cambodian aquaculture (65%, 79% and 88% for collectors, wholesalers and processors in the control group) (Figure 14). Within our sample, wholesalers sourced approximately 30% of their fish from Vietnam or Thailand (25% in control group). This ratio is reduced to 18% for collectors (only 3% in the control group).

The main fish traded by collectors and wholesalers are snakehead, walking catfish, and *Pangasius*, while processors rank giant snakehead as their main traded species. For the latter, dry salted giant snakehead is the main product sold. There is no filleting process. Differences between provinces are significant, with wholesalers in Battambang and Pursat trading larger volumes and/or value. Collectors have higher traded volumes in Kampong Cham, and Pursat has greater value traded (Annex F, Table L). However, the sample size is limited²⁶ and might not be representative.



Figure 14: Collectors, wholesalers, processors volume and origin of fish purchased in 2018 in treatment provinces

According to respondents, the average spoilage rate is low (below 5% on average in treatment group and 7 % and 18% for collectors and wholesalers of the control group). This reported figure is even more surprising given the lack of cold chain assets and low-level hygiene practices reported during this survey. Thus, these figures should be taken with caution. It might also reflect the specificity of the value chain where a significant amount of fish is sold alive. As mentioned previously, none of the respondents are applying any standard hygiene or phyto-sanitary practices in both control and treatment provinces. Use of ice should be mandatory, due to the important trade in live fish. Only a limited number of respondents reported using gloves, masks, or practices such as cleaning hands before and after handling

²⁶ For collectors, the sample size is n=22 and n=16 in treatment and control provinces, respectively, note that in Kampon Cham (n=1) and Pursat (n=5).

the products. Sub-standard hygiene practices such as having raw material in direct contact with the floor is still common in 30 to 40% of the sample. In control provinces, reported spoilage is higher (up to 18% of volume traded for wholesalers), but hygiene practices applied are similarly poor. Labelling of products also does not exist.

4.6. Support system

4.6.1. Access to loans

Producers and wholesalers represent the highest percentage of loan takers across the sample, with 66% of them having a loan in cash or in-kind ([Figure 15](#)). This percentage is lower down to 45% and 25% in the control group for producers and wholesalers respectively. Other respondents also report relatively high access to loans and one feed mill reports having a loan with a banking institution to support its activities. The average size of these loans is \$26,607 with a high interest rate of 1.33% per month or 13.2% per year in treatment province and 13.05% per year in average in control provinces.

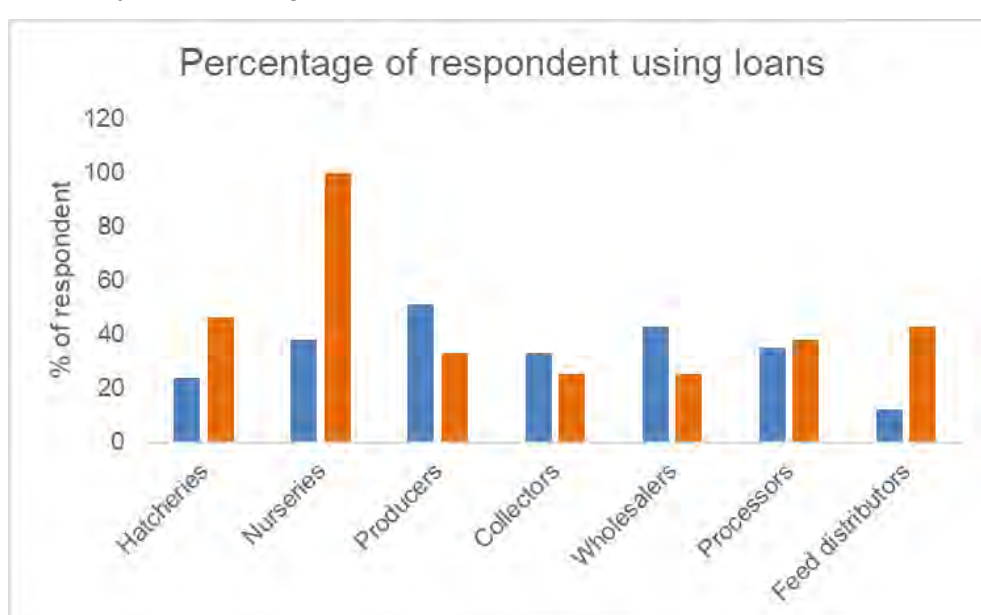


Figure 15: *Percentage of respondent using loans in the treatment and control groups*

Twenty-four percent of producers take out loans from MFI in both treatment and control groups with an average size of \$10,800 (\$ 6,350 in control group) for a duration of seven months (13 months in control group) and an interest rate of 1.5% per month. Buying fish feed is the main purpose of the loans, accounting for 68% of producers borrowing money from MFI. A similar pattern is observed in the control group, with 54% of the loan contracted to purchase feed.

Purchasing inputs (feed and seeds) was the most common reason for producers, hatcheries and nurseries to take loans (

Table 7, **ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS** Table B and C). Twenty-three percent of feed distributors reported providing feed as in-kind loan to farmers, charging KHR 100 to 500 per kilogram of feed in addition to the cost of feed, corresponding to an interest rate of 4-14% per production cycle. Other distributors reported providing feed in advance without interest charged to producers. These feed distributors provide between 10 and 60% of the aquaculture feed volume to farmers as in-kind loans.

According to the 17 MFIs interviewed, the limited number of aquaculture loans is a result of low demand (47% of answers). Only one respondent mentioned lack of collateral, and another cited high risk associated with aquaculture business. When considering the credit profile of the sector, it should be noted that self-reported information on debts is notoriously unreliable.

Table 7: Access to loan by different type of respondents

Respondents	Top two reasons for the loan
Hatcheries	1) land; 2) fish feed
Nurseries	1) fish feed; 2) fingerlings
Producers	1) fish feed; 2) fingerlings
Collectors	1) equipment; 2) vehicle
Wholesalers	1) equipment; 2) vehicle
Processors	1) raw material; 2) land, warehouse
Feed distributors	1) fish feed*

Note: feed distributors gave only a single reason to contract a loan.

4.6.2. Access to knowledge and information

Support systems for the aquaculture value chain are known to have a limited capacity (FiA, 2017). This fact is confirmed by the results of the survey. For example, only 13% of the producers received training in aquaculture technique in treatment group and 16% in the control group (Figure 16). Overall, only 17% of the entire survey sample across all respondent groups have ever received aquaculture training and the year when they attended their last training ranged from 1998 to 2019 (Figure 17; **ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table MError! Reference source not found.).

Training has a significant influence on adoption of improved feed practices, as well as the most frequently adopted improved management practices (Annex G). Although our sample is small, we found that nurseries, and especially hatcheries, in both control and treatment groups, have a relatively easy access to trainings. However, despite these trainings, we have seen that adoption of management and hygiene practices remains low, indicating that access to knowledge is not the only factor of adoption. Other factors, such as market demand for quality and premium prices could be significant drivers of adoption.

Feed manufacturers provide technical support to the feed distributor and producers in 41% of cases in treatment provinces, supplying on average 1-2 technicians. In control provinces the frequency of feed distributor providing support is higher, perhaps due to higher proportion of producers using feed pellet only. As a result, the average number of producers supported by a technician is 13.4 and 31 in treatment and control provinces respectively.

Very few of the feed distributors provided support to farmers, who also received training from the feed company, and only a few received training from development projects (3) or FiA (2). However, we found that in treatment provinces, only 41% of the feed distributors know how to use a feed table and only 30% provide those tables to farmers. This proportion is higher in control provinces (71% of feed distributors know how to use feed tables and 57% provide those tables to farmers), showing that level of knowledge and practices in those control provinces is perhaps higher when it comes to feeding practices.

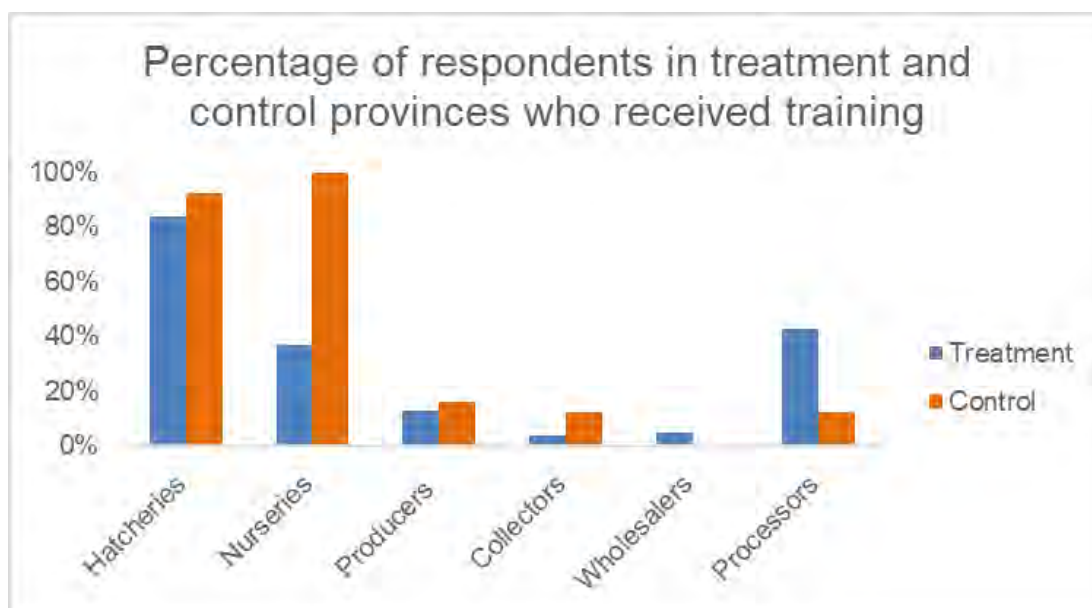


Figure 16: Percentage of respondents who received aquaculture related training in the past

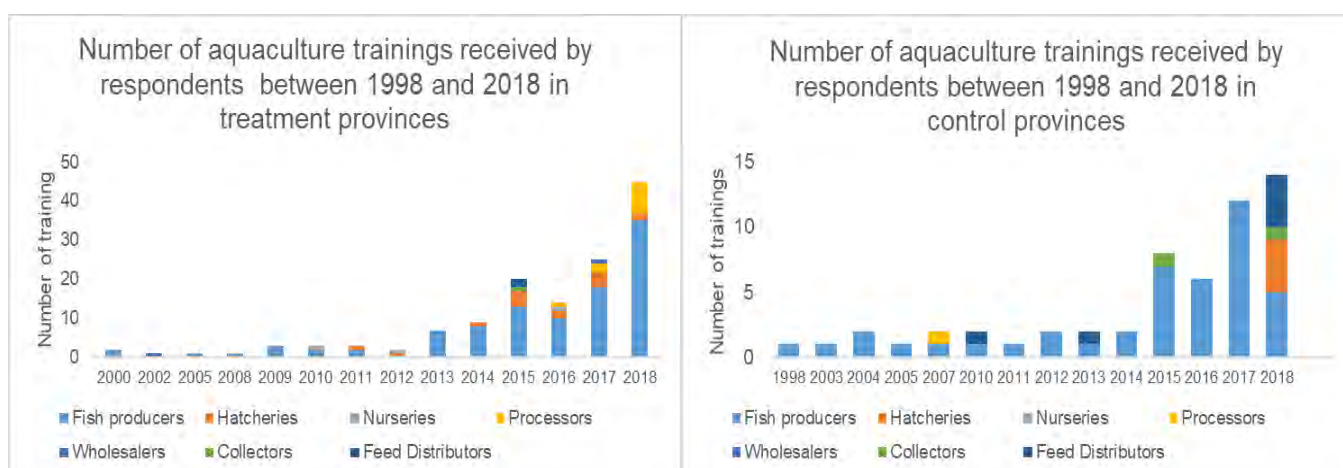


Figure 17: Aquaculture training received by respondents between 1998 and 2018 in treatment (left) and control (right) groups.

4.7. Aquaculture feed production and distribution

In 2018, all the pellet feed sold on the market was imported. Of the eight feed mills interviewed, one already invested and three plan to invest in aquaculture feed production, of which two are currently importing feed from Vietnam. Two of the eight respondents mentioned that the demand should reach two hundred thousand MT per year (one respondent) or one million MT per year to trigger investment into a feed mill. The three feed mills planning to produce, or who are currently importing aquaculture feed, are compliant with at least one international standard²⁷. Two claimed to be compliant to ISO 9001; ISO 14001 and ISO 22000, while another one claimed compliance with HACCP.

Of the three feed mills importing aquaculture feed, the quantity ranged from 100 to 2,000 MT. Those numbers are low and should be taken with caution. The average value of sale of

²⁷ ISO 9001: Quality management; ISO 14001: Environment System Certification; ISO 22000: Food safety management; HACCP Hazard Analysis and Critical Control Points; Best Aquaculture Practices; Global G.A.P. standard

US \$79,000. This figure is relatively low, and may also be under-reported. However, respondents estimate that reaching a production cost of US 50 cents for 1kg of *Pangasius* feed will make the feed competitive on the market. The feed mills reach their customer-base via their feed distributors at the district and provincial level, but also work directly with farmers, based on word of mouth. Only one feed mill reported having six technicians or more providing direct advice to farmers.

According to feed distributors, the best-selling feed in the treatment provinces is for *Pangasius*, followed by walking catfish. The price ranged between \$0.61 and \$0.87/kg for those different products in 2018. Green Feed company products are the most popular due to their competitive price. Among all the products, quality is ranked second as the main reason for success, indicating that farmers based their choice on price before quality. A similar pattern is observed in control provinces, although there is no clear brand domination. Forty-five percent of feed distributors had contract with one feed manufacturer, 8% with two, with an average contracted volume of sales of 5 to 300 MT per year. Those contracts include a minimum sales volume between 1 and 20 MT per month in 3% of the cases. Fifty respondents claimed that the feed manufacturers provide the feed in advance. For marketing, feed distributors enter into verbal contracts with farmers (35% of respondents in treatment provinces and 14% of respondent in control provinces), with contract volume varying from 250 kg to 2.5 MT per production cycle. Only one respondent reported a contract of 1 MT per production cycle in control provinces.

Access to pellet feed can be considered as good, with several brands and products available per province. However, the price for major fish species remains relatively high and hinders competitiveness of local producers with imported fish. Feed distributors have a very limited knowledge of the feed and feeding practices and do not necessarily support farmers.

4.8. Climate change adaptation

Extreme drought and flood events affect aquaculture production in Cambodia. Climate change studies (ICEM, 2013) identified those extreme events as key constraints to aquaculture in Cambodia. Participants in the USAID HARVEST program ranked drought and access to water, as the most significant factors for discontinuance of aquaculture (Richardson et al. 2018). Twenty-five percent of producers claimed to be affected by drought in the past 5 years, with the largest proportion in Kampong Cham (33%), Battambang (40%) and Pursat (44%) (Figure 18). Those provinces also have the highest proportion of farms equipped with wells. In control provinces, producers in Takeo report similar frequency (46%) of drought events (**ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table O). Cage producers can also face drought and low water levels. As a result, 45% of cage producers migrate their grow-out cages to deeper sections of the Tonle Sap lake or river when drought conditions exist. In control provinces, Kampong Chhnang and Banteay Meanchey present high vulnerability to drought, with 41% and 22% of the farms affected by a drought event in the past 5 years.

Twenty-eight percent of pond producers were affected by flood in the last five years. The largest proportion are found in Kandal (44%) and Kampong Cham (52%) Provinces (Annex F, Table P). When considering only ponds, the proportion increased to 89% (Pursat), 63% in Kandal and 55% in Kampong Cham. Of the producers affected by flood, only 43% fenced their pond, with proportion as low as 13 and 14% in Kampong Thom and Siem Reap. Forty-one percent of hatcheries and twenty-one percent of nurseries are affected by flood, and only 42 and 21% of those affected farms having fenced ponds, respectively. In control provinces, flooding is a constraint for producers in Banteay Meanchey (27% of producers) and Kampong Chhnang (32%), but not in Takeo (5% only).

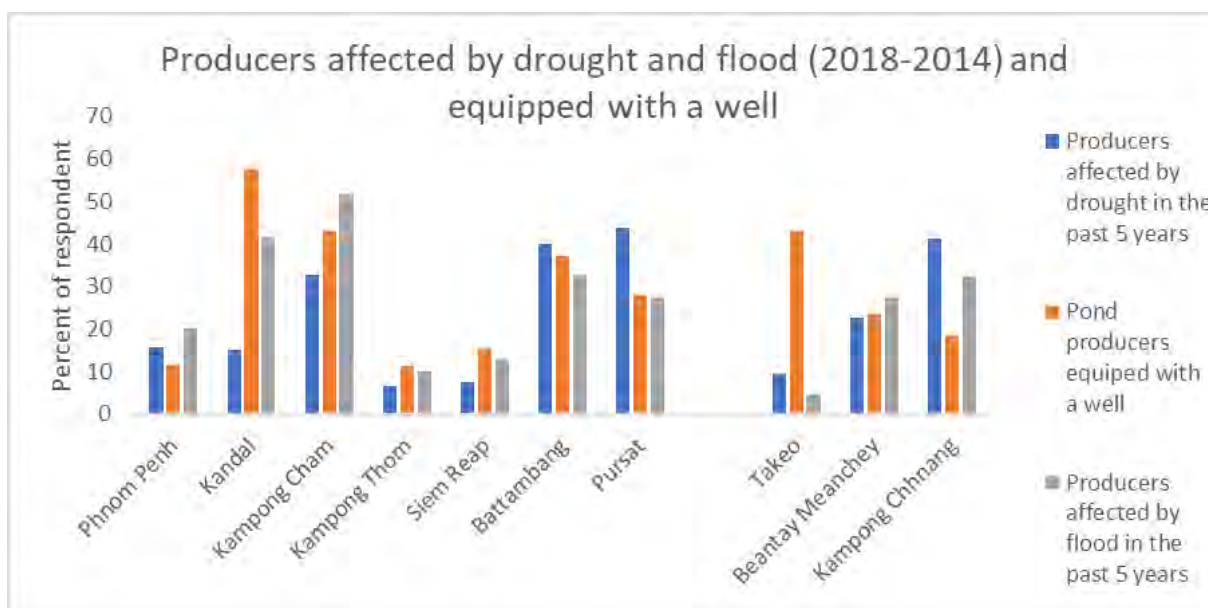


Figure 18: Percentage of producers affected by drought and flood and equipped with a well in treatment and control provinces

4.9. Spatial distribution of farmer clusters and processing hubs

Figure 19 **Error! Reference source not found.** shows the clusters of producers in the treatment provinces, and also potential sources of fingerlings. In **ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Figure B, we identified potential farmer leaders²⁸ and top 5 communes of producers in each province (see **ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table Q).

Co-variate analysis shows that Phnom Penh producers have significantly higher production and value of sales, due to larger pond area. No significant difference was observed for pond and cage yield across provinces, although cage producers in Battambang and Kampong Thom present average yield above 65kg/m³. Siem Reap, Phnom Penh and Kandal pond producers record yield above 8 kg/m².

Observations made during the scoping mission and field survey identified several clusters of producers in the surveyed provinces. In Kampong Cham Province, aquaculture pond producers, focusing on giant snakehead and *Pangasius* culture were identified in Batheay, Prey Chhor, Kampong Siem, and Cheung Prey Districts. Stuong and Kampong Svay Districts in Kampong Thom Province have several clusters of pond or cage aquaculture farmers, focusing on giant snakehead and/or *Pangasius*. A similar pattern was found in Siem Reap Province in Soutr Nikom, Siem Reap, Chi Kraeng, and Puk Districts. In those three provinces, Vietnam is the main source of fingerlings and fish is sold to the urban centers and for export to other provinces. Some of those clusters include farmers from Kinh ethnic group from Vietnam. Clusters of giant snakehead farmers are found in Krakor, Pursat, Kandeang and Bakan Districts within Pursat Province. Those clusters operate with trash fish based feed and floating pellets. Fingerlings are sourced from nurseries (importers) in Preak Pnov, near Phnom Penh or directly imported from Vietnam. Farmers are from Khmer or Kinh ethnic groups from Vietnam.

Clusters in Battambang Province (Sangker and Aek Phnom Districts) are dominated by snakehead culture, but with some culture of tilapia, *Pangasius* and walking catfish. Fingerlings

²⁸ We selected the top 15 fish producers in terms of volume produced per year in each province

are sourced from Vietnam, but also from nurseries located in Battambang, and the feeding regime is based on trash fish and homemade feed.

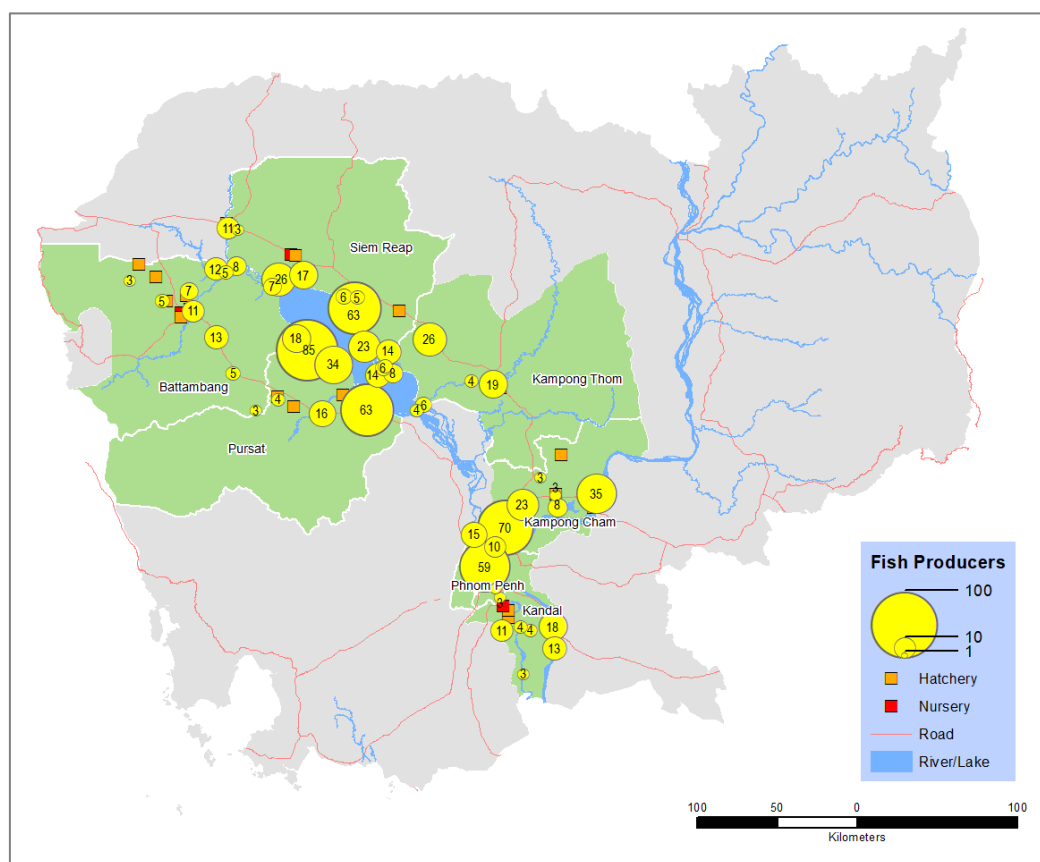


Figure 19: Cluster of producers (number of farms within 5 km radius), hatcheries and nurseries surveyed in treatment provinces. * The circle symbol shows the center of each cluster and is scaled to the number of aquaculture farms falling within the cluster.

Clusters of producers are found in Preaek Pnov District in Phnom Penh, and Phonhea Leu and Kien Svay Districts in Kandal Province. In both provinces, *Pangasius*, snakehead species are dominant with some tilapia culture and red tail catfish culture. Those farms are operated by Khmer, Cham or Kinh ethnic group members. Phnom Penh markets, and major landing sites in Chraing Chamres and Prek Phnov Districts, are the main the destination of this production.

Within the treatment provinces, we identified seven major landing sites where aquaculture fish are traded (Table 8). Local and imported aquaculture products, as well as capture fisheries products, are traded on those sites before re-distribution to retailers.

Table 8: List of major landing site for aquaculture products

Name	Province	Commune
Landing site: Kampong Kleang	Siem Reap	Kampong Kleang
Landing site: Chhong Kneas	Siem Reap	Siem Reap
Individual landing site/market (Hok Kean)	Kampong Chham	Krong Kampong Cham
Raing Til	Pursat	Raing Til
Kdol Tahaen	Battambang	Kdol Tahaen
Chraing Chamres	Phnom Penh	Phnom Penh
Prek Phnov	Phnom Penh	Phnom Penh

Identified locations of processing hubs (e.g., location with significant concentration of fish processors) are presented in Table 9. Several of those sites (Prek Phnov; Suong; Siem Reap) include medium-scale processors, operating with several hired workers.

Producers and hubs for trading and processing fish are well distributed across provinces. We found that the export of processed product is limited, even in Battambang, where Thai traders are reported to be operating. The market is heavily concentrated in a few hubs or landing sites, where fish is re-distributed to final markets. At these hubs, the aquaculture value chain merges with capture fisheries and imported fish, which renders the quality and traceability control more complex.

Table 9: List of major processing hubs

Name	Province	Commune	Main product
Fish processing hub	Kampong Cham	Kien Chrey	Dry fish
Fish processing hub	Siem Reap	Siem Reap	Dry Fish
Suong	Kampong Thom	Kampong Chen Tboung	Dry fish
Kampong Thom town (Ah Chharleak)	Kampong Thom	Kampong thom	Dry & smoked fish
Tang Krasang	Kampong Thom		Dry & smoked fish
Prahok Market	Battambang	Daun Teav	Fish paste
Fish processing hub	Pursat	Kompong Luong	Dry fish
Fish processing hub	Pursat	Raing Til	Dry fish
Kampong Loung	Kandal	Kampong Loung	Fish paste
S'ang	Kandal	S'ang	Fish paste
Prek Phnov	Phnom Penh	Prek Phnov	Dry fish,
Chba Ampov	Phnom Penh	Chba Ampov	Dry fish

5. STANDARD AND CUSTOM INDICATORS

This section builds on the population-based survey results to present results for the FFPr Standard and Custom indicators. Annex D presents summary tables for all indicators for treatment and control provinces.

5.1. Infrastructure and assets

Custom indicator #6²⁹ and Custom indicator #7³⁰ relate to the infrastructure and assets owned by the different type of respondents. An analysis of the infrastructure and assets found on producer farms and hatcheries has already been presented in Sections 4.3 and 4.4. Fifty-five percent of the producers are pond farmers and forty-five percent are cage farmers, in the treatment provinces and this ratio is slightly different in the control province with only 35% of the producers operating cages, all located in Kampong Chhnang Province. Production and value of production is correlated with the surface area and cage volume of production (see section 6.1 and **ANNEX G: COVARIATES ANALYSIS**). In control groups the number and area of production assets is within the same range as the treatment group (Figure 20).

In Section 4.5 we presented the main activities and assets of post-harvest respondents. Custom indicator #7 concerns post-harvest respondent' assets and infrastructure to trade and process fish. For these actors, we assessed three categories of assets: i) transportation assets; ii) storage assets; iii) transformation assets (see **ANNEX D: STANDARD AND CUSTOM INDICATORS** for detailed results).

²⁹ Custom indicator #6 : Number of farms that increased the number, size, or amount of ponds, cages or equipment with USDA assistance

³⁰ Custom indicator #7 :Number of value chain actors with increased capacity for distribution including processing and/or other value addition practices on assets held by post-harvest actors for i) storage; ii) transformation ; iii) transportation assets (as of 2018)

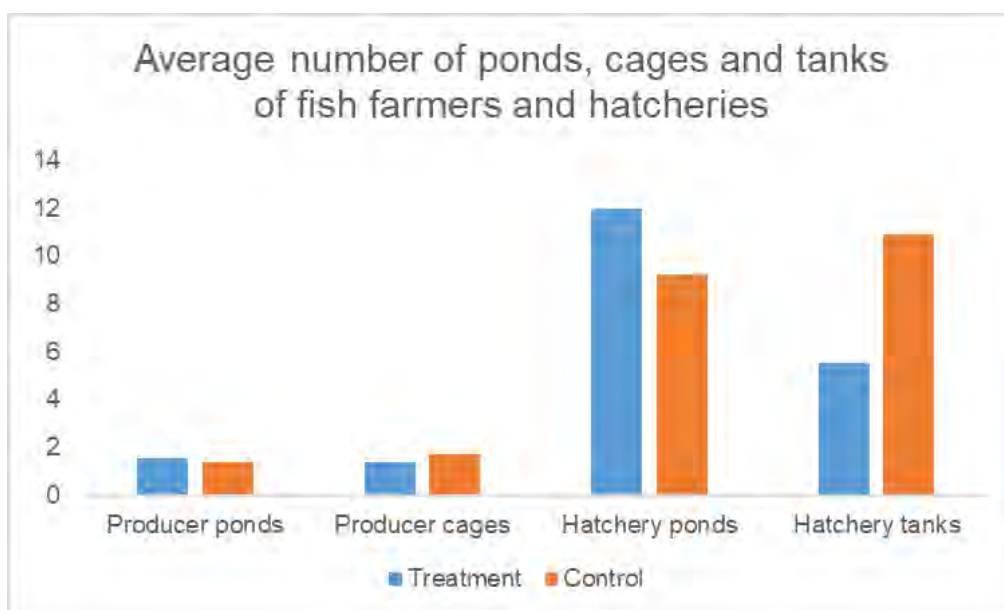


Figure 20: Average number of production assets of fish farmers and hatcheries

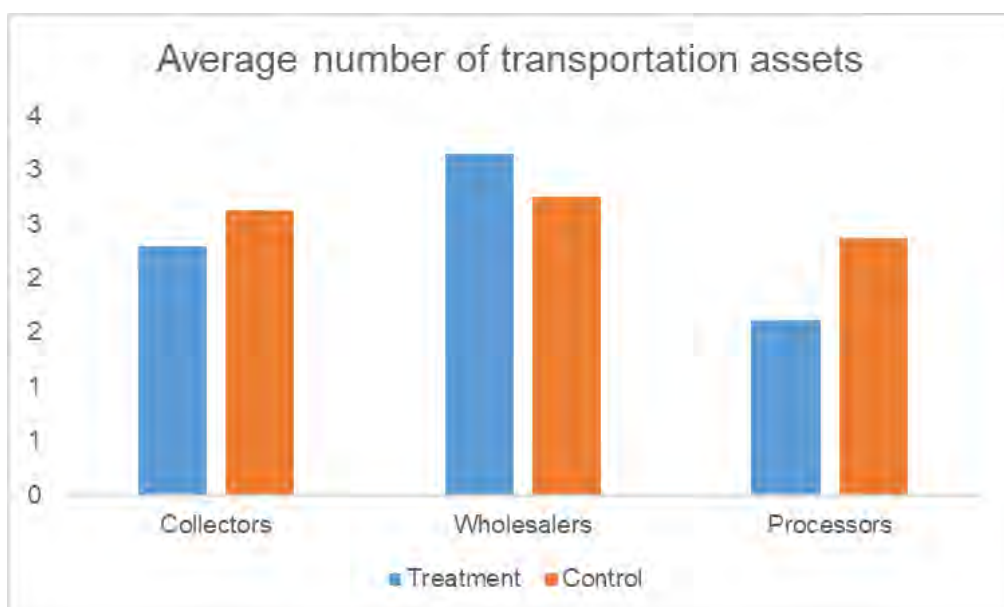


Figure 21: Average number of transportation assets³¹ of collectors, wholesalers and processors in control and treatment provinces

Twenty percent of the collectors and twelve percent of wholesalers operate directly from their households and do not have a specific warehouse. Average storage capacity is 38 MT for collectors, 49 MT for wholesalers to 92 MT for processors. On average, wholesalers have more transport tanks than collectors (mean of 18 vs 12, respectively). Only seven respondents, or 10% own refrigerators in the treatment group, and 6% in the control group. Eighty three percent of processors own solar dryers, with an average area of 26 m². Stoves are rarer, being owned by only four processors (15% of treatment group) and only one processor (12%) in the control group. The number of transportation assets is similar across actors, with varying types. Wholesalers have higher capacity transportation, with an average

³¹ Transportation assets include: i) motorcycles; ii) carts; iii) cars; iv) motorized boats; v) mini-vans; vi) small trucks (4 wheels); vii) large trucks (6 or more wheels).

1.6 large transportation assets (car, truck or mini-van), compare to collectors (<1 per collector) (Figure 21).

Within our sample there were no respondents with assets and infrastructure to process fish at an industrial level, such as filleting. Cold chain is limited and storage assets concern fish sold alive, and dead fish on ice. Meanwhile, the different respondents have transportation assets, according to their scale. Processing equipment is also limited to family- or small-scale activities.

5.2. Production and value of aquaculture products

This section concerns Standard indicator #1³², Standard indicator #18³³ and Standard indicator #19³⁴. Average yield is not significantly different between treatment and control provinces (**ANNEX G: COVARIATES ANALYSIS**, see section 3.1). In terms of volume, *Pangasius* is the main species produced (4,675 MT, or 57% of the total aquaculture production) and ranks first in five of the seven treatment provinces (Annex F, Table E). Phnom Penh has higher production volume and value of sales than other provinces, due to larger area and volume of production.

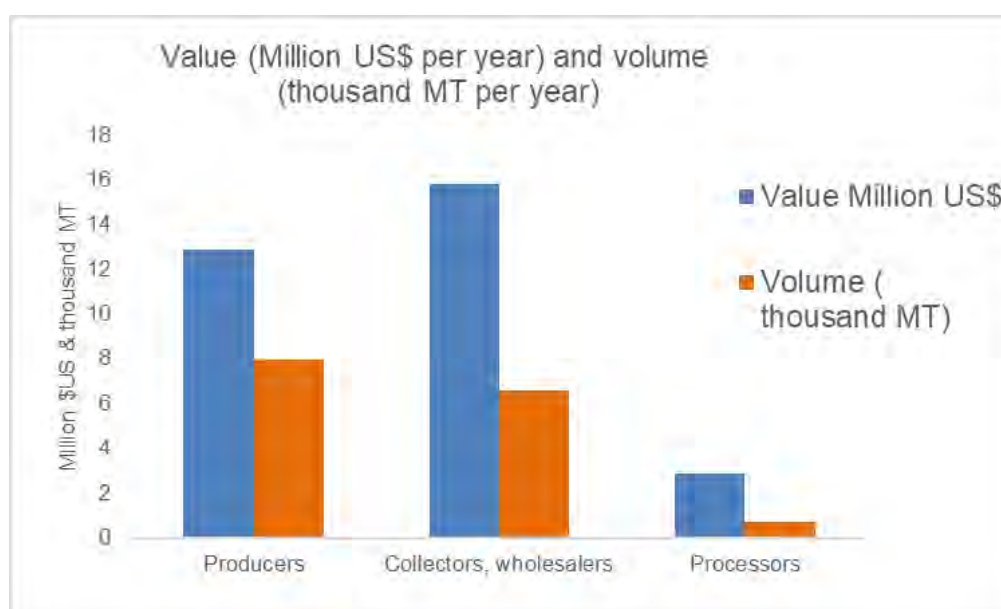


Figure 22: Total value (Million US\$) and volume (thousand metric ton) Cambodian product sold by producers, collectors, wholesalers and processors in treatment provinces.

Within commonly produced species, the most valuable is red-tail catfish (*Hemibagrus wyckioides*), with an average selling price of \$3.02/kg and mostly produced in Phnom Penh and Kampong Chhnang Provinces. Interestingly, differences are seen in the selling price between pond and cage production for the same species (e.g., giant snakehead \$1.94/kg for cage vs \$2.26/kg for pond). Silver barb also achieved a higher market price (> \$2/kg). However, the data collected does not allow an analysis of the price difference between live and dead fish. We found that prices are on average four to 10% lower in control provinces for the *Pangasius* and giant snakehead.

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³² Standard indicator #1: Yield of targeted agricultural commodities among program participants with USDA assistance

³³ Standard indicator #18: Volume of commodities (metric tons) sold by farms and firms receiving USDA assistance

³⁴ Standard indicator #19: Value of annual sales of farms and firms receiving USDA assistance

processors, are presented in [Figure 22](#). Collectors and wholesalers makeup the largest share, in terms of value, as the products can be double counted, as they may be re-sold from collectors to wholesalers. The volume and value of processors appears low due to their limited processing capacity. Also, the volume data corresponds to the volume of product sold, after processing. Moisture content of dry and smoked fish is significantly lower than live fish or dead fish on ice. The proportion of aquaculture fish sourced from Cambodia by wholesalers and processors is 68% and 64%, respectively (**ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS**, Table J). The proportion of imported aquaculture fish remains significant, representing 19% and 30% of the total volume of collectors and wholesalers respectively. More than 80% of the aquaculture fish traded are live fish – representing a higher value niche. A similar pattern was recorded in control provinces, but with less fish sold alive (60% and 36% for collector and wholesalers, respectively), but a higher share of raw material is sourced from Cambodian aquaculture.

5.3. Management practices of producers and input suppliers

Standard indicator #2³⁵, Standard indicator #3³⁶, Standard indicator #4³⁷, Custom indicator #3³⁸ and Custom indicator #11³⁹ are presented in this section. Management practices of producers and suppliers have been described in Sections 4.3, 4.4, and 4.5. The indicators that report improved management practices are constructed based on several sub-indicators, reflecting an array of technology and practices (see section 2.1.8). From our evaluation, 155 farms, 14 hatcheries and four nurseries operators employed improved management practices (Standard indicator #4) from at least one of the following sub-types: aquaculture management practices, adaptation to climate change, other (marketing, post-harvest handling and business management) ([Figure 23](#)). This corresponds to 41 hectares (ha), or only 17% of the producers, leaving the vast majority of respondents operating with low level practices (Standard indicator #3). In the control group, 34 producers (11% of the sample), seven hatcheries (53% of the sample) and one nursery employed improved management practices, corresponding to an area of 20 hectares.

There is a logical relation between low-level practice and the absence of quality inputs, with no hatcheries, nurseries or feed mill producing international quality standard products (Custom indicator #3). Area already under climate change adaption is estimated at 44.3 ha in the treatment provinces, and 13.8 ha in control provinces (Standard indicator #2). Most of the producers operating ponds in flooded areas have fenced ponds, meanwhile drought is still a concern to farmers, and ground water use is not well developed (Section 4.8). In control provinces, access to ground water is variable across provinces, as well as fencing ponds in flooded areas.

35 Standard indicator #2: Number of hectares under improved management practices or technologies that promote improved climate risk reduction and/or natural resources management with USDA assistance

36 Standard indicator #3: Number of hectares under improved management practices or technologies with USDA assistance

37 Standard indicator #4: Number of individuals in the agriculture system who have applied improved management practices or technologies with USDA assistance

38 Custom indicator #3: Number of hatcheries or feed mills that are supplying seed or feed that meets improved quality standards

39 Custom indicator #11: Number of business plans developed that include marketing and distribution strategies

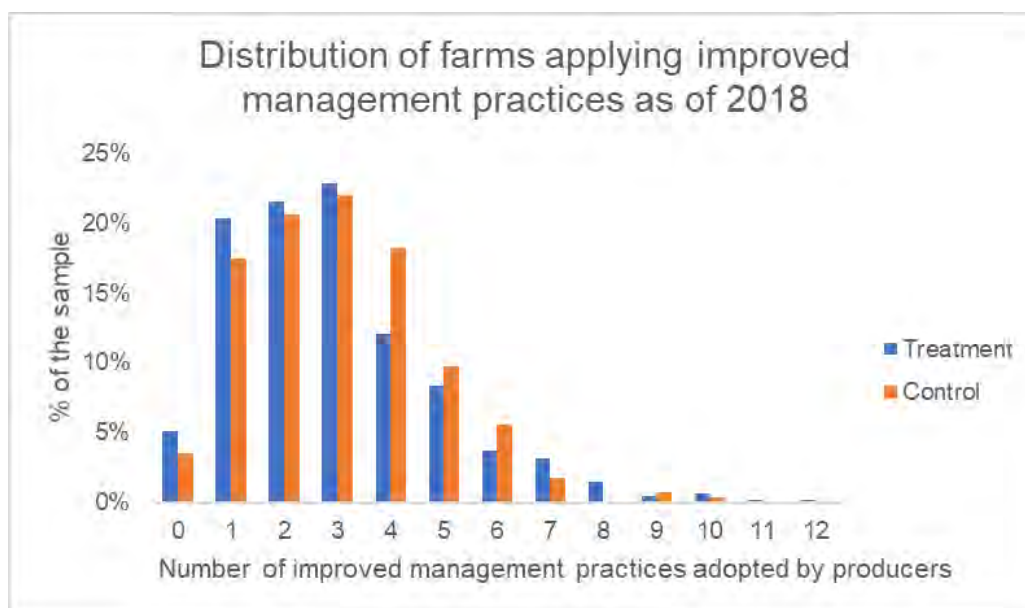


Figure 23: Distribution of adoption of improvement management practices in treatment and control groups of producers

Only 94 respondents (or 9%) are considered to have a “business plan”. A similar ratio is observed in the control group (8.5%). As a result, only one hatchery is considered as having a business plan in the treatment group and three in the control group (Custom indicator #11). One positive characteristic found was a tendency for producers, hatcheries, nurseries, to record their sales, but less so, their inputs. As a result, those respondents do not know their production cost. Nursery and hatchery operators have a network of clients with trusted relationships in different provinces, but 68% of them do not have any sort of contract with buyers. This type of practice is also common in the control group (50% of hatcheries and nurseries).

Feed mills, currently producing animal feed, do apply several of the marketing and distribution and other practices we monitored but none are considered as having a business plan. Although they have established agreements with buyers, they have limited distribution tools, such as on-line tools for ordering products.

5.4. Post-harvest related indicators

This section present Standard indicator #4⁴⁰, Custom indicator #5⁴¹, Custom indicator #10⁴² and Custom indicator #11⁴³. Processors purchase their fish from either collectors or directly from the farm-gate. For collectors, processors and wholesalers, marketing and distribution is based on verbal contract, without indication of date or volume. Marketing and trading are based on personal relationships/networks and forecasting volume needs and economic return from fish trading or processing activities is not common. None of the post-harvest actors can be considered as having a business plan based on their response (Custom indicator #11) (Table 10).

⁴⁰ Standard indicator #4: Number of individuals in the agriculture system who have applied improved management practices or technologies with USDA assistance

⁴¹ Custom indicator #5: Number of market actors who are compliant with standard SPS best practices and/or are using an independent quality seal to market their products

⁴² Custom indicator #11: Number of business plans developed that include marketing and distribution strategies

⁴³ Custom#11 indicator: Number of business plans developed that include marketing and distribution strategies

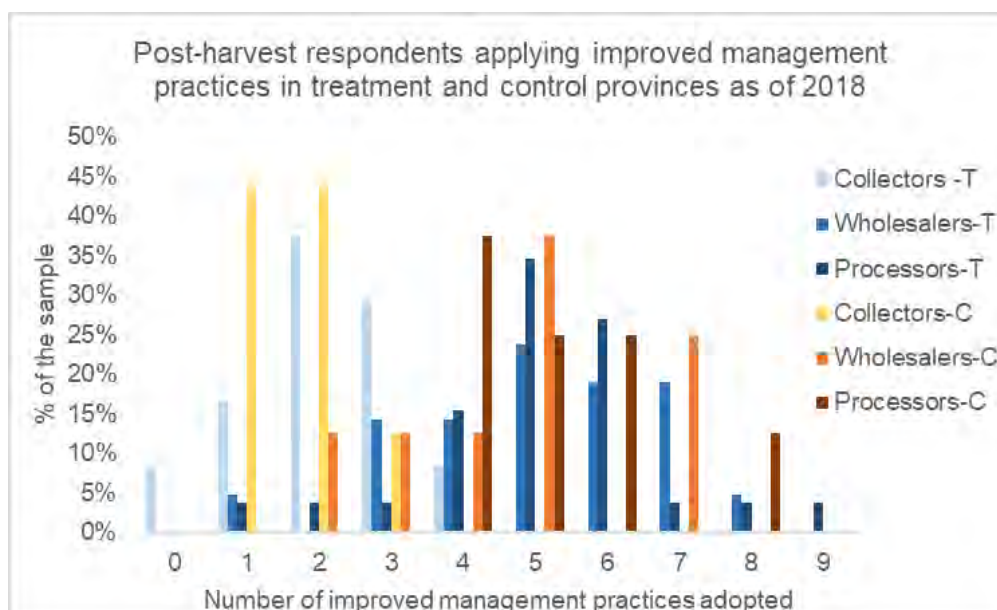


Figure 24: Distribution of adoption of improvement management practices of collectors, wholesalers and processors in treatment (T) and control group (C)

The number of improved management practices already deployed by post-harvest respondents in both control and treatment provinces is shown in [Figure 24](#). Hygiene and quality standards in fish trading and processing are central to CAST activities. No respondents were found to follow any standard procedures when processing or trading fish. In general, quality and hygiene standards are low or non-existent (e.g., the low use of refrigerators) (two respondents only in treatment group, one in the control group) or refrigerated trucks (two respondents only, one in the treatment group, one in the control group). Ice is used when storing and transporting fish, but the quality of the ice is unknown, as 97% of the participants do not perform a quality check (100% in the control group) (Annex F, Table K). The key hygiene practices⁴⁴ monitored are only followed by 20-45% of processors and wholesalers in both control and treatment groups. No firm in both treatment and control groups, is compliant with SPS or other standard for fisheries products in Cambodia (Custom indicator #5), and no private-sector retailers (such as AEON Mall, Chip Mong supermarket or Natural Garden grocery store) demand their own standards for fisheries products. Recording the origin of the product is not a common practice, nor is labeling the product with clear identification of the manufacturer, date of manufacture, or expiration date.

During the scoping mission, WorldFish observed that, although processors are aware of hygiene standards, they are reluctant to implement them due to the high costs involved, and lack of premium return for higher quality. On the positive side, several processors and retailers mentioned that marketing fish produce in Cambodia is getting easier, and they see the emergence of a market demand for quality products, as consumers are becoming more willing to pay higher prices.

⁴⁴ use of safe ice; using gloves and mask; employee washing hands; fish not in contact with floor; using detergent to clean equipment; using specific containers to store waste from processing.

Table 10: Results for Standard indicator #4⁴⁵; Custom indicator #11⁴⁶, Custom indicator #5⁴⁷ and perception of the quality of Cambodian aquaculture product (related to Custom indicator #10⁴⁸) in treatment provinces

	Number of individuals following improved management in 2018	Number of firms having a business plan in 2018	Number of firms compliant to SPS and standards available in Cambodia in 2018	Perception of Aquaculture fish quality *
	Standard#4	Custom#11	Custom#5	Custom#10
Collectors	0	0	0	3.8 (0.6)
Wholesalers	1	0	0	4.1 (0.7)
Processors	2	0	0	3.9 (0.6)

*Note: Perception of Aquaculture fish quality range on a scale 1 to 5 (1: very low; 2: low; 3: average; 4: good; 5: very good)

5.5. Access to loans and information

Standards indicators #5, #7, #8⁴⁹ refers to financial services related to USDA assistance. Therefore, baseline indicator value is null. However, the rate of access to loans for the different respondents has been presented in Section 4.6.1. This information shows that approximately 66% of producers in the treatment group (45% in the control group) access loans to purchase inputs, either in kind or in cash from formal and informal lenders. Twenty-four percent of producers access loans from MFI or banks, mostly to purchase fish feed. We also found that the interest rates of MFIs are high (13% per year, ranging from 10% to 16%), which could discourage further investment in operations and infrastructure. A similar range is observed in the control province.

Custom indicator #4⁵⁰, report 79% of respondents as having access to information related to aquaculture technique, inputs, market or quality (**ANNEX D: STANDARD AND CUSTOM INDICATORS**). Sections 4.4 and 4.6.2, include additional information about access to information for producers. Other respondents claim to have received information about market or techniques in all the different categories surveyed (**Figure 25, ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS** Table N). Differences between treatment and control groups are important in terms of accessing information about processed fish prices, price of fish sold alive, and quality and standard, for the post-harvest actors. The treatment group tends to have better access to information. In addition, in the control group, hatcheries, producers and feed distributors are less informed. Those groups claimed to received information only in 8%, 54% and 55% of the cases, respectively.

⁴⁵ Number of individuals in the agriculture system who have applied improved management practices or technologies with USDA assistance

⁴⁶ Number of business plans developed that include marketing and distribution strategies

⁴⁷ Number of market actors who are compliant with standard SPS best practices and/or are using an independent quality seal to market their products

⁴⁸ Number of post-production market actors who report an increase in volume or improvement in the quality of freshwater fish in the aquaculture value chain

⁴⁹ Standard indicator #5: Number of individuals accessing agriculture-related financing as a result of USDA assistance; Standard indicator #7: Number of loans disbursed as a result of USDA assistance; Standard indicator # 8: Value of agriculture-related financing accessed as a result of USDA assistance

⁵⁰ Custom#4 indicator: Number of beneficiaries who received market information about price and availability of aquaculture products

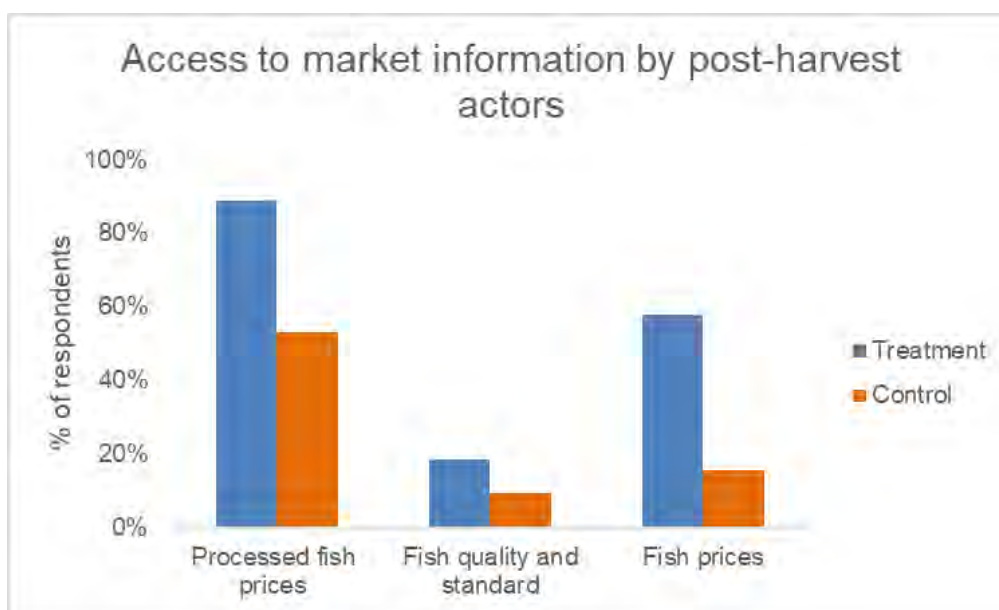


Figure 25: Percentage of wholesalers and processors that claimed to receive market information about i) processed fish price; 2) live and dead on ice fish price; 3) fish quality and standard.

Access to technical information and knowledge about fish farming remains limited in terms of diversity and exposure. Information regarding standard and quality of fish is also very limited, even in the post-harvest segments of the value chain. Access to fish prices is frequent, but the main source (usually the buyer) cannot be considered as independent. Extension and access to knowledge and market information is limited. There is no common platform at provincial or national level to facilitate access and sharing of information related to aquaculture inputs and products. As analyzed by Richardson et al. 2017, access to knowledge and training is limited to project support, while capacity of extension services to provide such support is low.

6. COVARIATE AND CONFOUNDER ANALYSIS AND PROPENSITY SCORE MATCHING

6.1. Covariate analysis

We conducted covariate analysis for key variables (volume, value, yield, pellet feed use, top species produced, top aquaculture management practice, top post-harvest business practice) using potential covariates (province, age, gender, past project participation, loan recipient, control v. treatment, and production type as appropriate; see Section 2.1.9). We conducted analysis of production volume, value, and yield variables by pond area and cage size to provide greater understanding of the covariate analysis results. However, pond area and cage size should not be considered covariates as they are potential target variables of the project. Detailed tables of results can be found in **ANNEX G: COVARIATES ANALYSIS** of this report.

Importantly, 2018 farm yield (for ponds, kg of fish produced per m²; for cages, kg of fish produced per m³) was not influenced by any of the potential covariates. Based on these findings, project interventions that focus on improving yield are likely to influence farms without significant covariation. Pond and cage yields had slight negative correlations with area of pond and volume of cage (respectively), indicating that smaller farm units are slightly more productive. Based on this finding, it may be more effective to increase number of farms, rather

than size of farms, to enhance total productivity of the aquaculture sector in the treatment provinces.

Sales volume and value from aquaculture production and trade varied only by province as a covariate. For producers, volume and value of fish produced in the Phnom Penh municipality was significantly higher than the mean of the total sample of all provinces/municipalities. The main factor contributing to this difference is larger pond area of those farms. We found this matched the overall trend, that pond area and cage volume were positively and significantly correlated with the volume and value of sale of the farms, as logical inference would predict. Because yield had slight negative correlations with pond area and cage volume, we caution against the conclusion that bigger farms will most effectively enhance aquaculture production in the treatment provinces. The findings on yield, volume, and value altogether suggest that while per farm volume and value certainly increase with pond area and cage volume, interventions to improve pond and cage yield and an increase in the number of small farms are likely the most production-efficient means of improving aquaculture sales volume and value in the treatment provinces.

Use of pellet feed was not influenced by age or gender of producer, but was influenced by province, access to loans, participation in a past aquaculture project, production type, and control vs. treatment. Of particular note, past project participation most positively influenced pellet feed use. We suggest that a pellet feed intervention is likely to be taken up and maintained by beneficiaries.

Volume and value of aquaculture products in the post-harvest segment differed significantly between provinces. For collectors, traded fish volume was significantly high in Phnom Penh and Kampong Cham, while traded fish value was significantly high in Pursat. For wholesalers, traded fish volume was significantly high in Battambang; traded fish value was significantly high in both Battambang and Banteay Meanchey. For processors, fish volume was significantly high in Kampong Chhnang; fish value was significantly high in Pursat. Due to small numbers of collector, wholesaler, and processor respondents, it is difficult to determine the reasons for the province differences of these actors. However, we suggest the project account for these provincial differences by targeting the high trade volume and value provinces of Pursat, Kampong Chhnang and Battambang Provinces for their post-harvest activities, in addition to the main urban markets (Phnom Penh and Siem Reap).

No significant difference was found between the value or volume of fingerlings traded by hatcheries or nurseries. However, some provinces do not have hatcheries or nurseries (no hatchery in Phnom Penh, no nursery in Pursat or Kampong Chhnang, and neither hatcheries nor nurseries in Banteay Meanchey). As previous project participation and access to loans did influence the production and value generated by hatcheries and nurseries, we hypothesize that access to knowledge and technology to increase production in these facilities can be achieved through a variety of means, not only through projects and loans.

Province, age, gender of aquaculture farmer, and access to loans, were found to be significant covariates for the main species raised by farmers. The main species by province differs and CAST project should adapt to that specificity and propose different technical packages and business model tailored to the most common species. Key findings included the stocking of *Pangasius* more often in control provinces and farmers more frequently use feed pellets, compared to treatment provinces.

When exploring covariates that explain differences in adoption of the top aquaculture management practices by producer, province and participation in past aquaculture projects were found to be significant. Similar analysis for post-harvest and business management practices shows that province, age, gender, beneficiary of past project, recipient of a loan, all

have significant influence on having a contract agreement with buyer (top post-harvest and business management practices). Of particular note, more producers in treatment provinces have contracts/agreements with buyers than producers in the control provinces (Annex G).

Overall, control and treatment groups are comparable and aquaculture farmers operate at the same performance level in many instances, other than for the most frequently raised species and the business management practices. Those two variables should be taken into account when analyzing the impact of the project, particularly regarding Standard #3, Standard #4 and Custom #11 indicators. For volume and value of fish product traded, there is no significant difference between control and treatment provinces.

6.2. Confounder variables

In this section, we present possible confounder variables, or variables operating outside of the causal pathway but that might influence the project outcomes..

Table 11: Potential confounder variables influencing CAST outcomes

Dimension	Confounder variable
Environmental	• Change in rainfall pattern and extreme drought or flood events in part or all provinces may affect on-farm production and management practices. • Increase in temperature may affect on-farm yield and post-harvest losses. • Change in availability and quality of water from lakes, rivers, and reservoirs may affect production especially in dry season.
Social	• Land consolidation and sales may affect size and location of farm operations, especially in Phnom Penh municipality and Kandal Province where rapid urban development is taking place⁵¹. • Planned resettlement of floating villages currently operating cage farming on the Tonle Sap Lake and River may affect the number of beneficiaries, production and yield in both treatment and control provinces. • Predatory loans and debt defaults may affect land holdings of target beneficiaries and/or participation to the project.
Economic	• Growth in other economic sectors (such as construction and manufacturing) may continue to remove labor force away from agriculture sector in general, including aquaculture. • Changes in financial market conditions may influence lending schemes of MFIs.
Political and institutional	• Ongoing revision of the Law on Fisheries may create new opportunities and/or barriers for aquaculture sector in general. • Changes in cross border trade regulations may affect import of aquaculture inputs and products and price of fish and inputs. • Other donor or private sector investments in aquaculture development in control and treatment provinces (e.g., EU-funded CAPFish Aquaculture) may influence technical support and services available to beneficiaries. • Changes in trade regulations to major export market for fish products (China, E.U) may affect entire value chains.
Infrastructure	• Ongoing expansion of road networks will influence access to markets, services, products, and affect location of farmer clusters and value chains. • Ongoing expansion of irrigation water storage and distribution infrastructure will influence water availability and quality for aquaculture production systems and its feasibility in various geographic areas.

⁵¹ <https://www.phnompenhpost.com/post-property/land-prices-three-capital-districts-see-sharp-increase>

Detailed statistics and data at sub-national levels are not readily available for environmental, social, political and institutional, geographic and infrastructure, and economic factors in Cambodia, and thus we are not able to conduct systematic, quantitative confounder analysis. Instead, we provide a list of factors that potentially influence CAST project intervention during the implementation period ([Table 11](#)). This assessment is based on WorldFish staff knowledge and experience from working in Cambodia over the last 20 years.

6.3. Propensity Score Matching (PSM) analysis

We conducted a PSM analysis using the following variables to match individuals from control groups with individuals from treatment groups for aquaculture producers only. The matching was done at the farm level, which means many parcel-, individual- and crop-level characteristics are converted into farm-level variables. Details of observable attributes incorporated in the score calculation include demographic conditions and other farm characteristics. We planned to use 11 variables to perform PSM. However, after multiple tests, we excluded the “main source of water”, and “province” variables, reducing the number of variables to nine. Those variables were excluded due to insufficient sample sizes for PSM performance.

As a result, the PSM analysis included the following variables: 1) age and 2) gender of farmer, 3) recipient of a loan, 4) type of production system (cage or pond), 5) the number of cages and ponds, 6) total farm size, 7) pond area, 8) household labor (by gender and class ages), and 9) long-term employment status; 10) years of aquaculture production. A common rule in PSM analysis is to include variables that return a standardized mean bias below 3% or 5% after matching. The PSM structure proposed in this analysis passes this balancing score, as the mean bias of some variables (production type or farm size) exceeds the 5% threshold. However, the balancing score is still within an acceptable range. Further improvement of the structure would be needed when conducting the project's final impact evaluation, in order to capture a high accuracy. Usually, this task would be performed only in the mid-term or end-line study. The method used for calculating the propensity score is described in Section 2.1.9.

We then matched potential beneficiaries and non-beneficiaries (which are on common support) across treatment and control provinces, based on the estimated score. This process reduced the number of potential beneficiaries from 918 to 873 – indicating that the matching has to some extent reduced the difference between the potential beneficiaries and non-beneficiaries as shown in **ANNEX G: COVARIATES ANALYSIS**, Figure C. We provide the list of un-matched households in **ANNEX G: COVARIATES ANALYSIS**, Table S and the results of the standardized mean bias of the variable used in the PSM in Table U

7. QUALITATIVE STUDY

This section presents quantitative and qualitative information and analysis of the KIIs in relation to three areas:

- The aquaculture industry
- Project implementation
- Relationship building.

Forty-six interviews were conducted with a range of relevant actors in the Cambodian aquaculture sector, including development partners, government representatives, Microfinance Institutions (MFIs), Hotels, Restaurants and Caterers (HORECA), producers, nurseries, hatcheries and post-harvest actors.

7.1. Aquaculture industry

7.1.1. Constraints and opportunities to development of commercial aquaculture sector

Numerous constraints to the development of commercial aquaculture sector were identified during the interviews. Of these, limited access to quality inputs, such as feed and fingerlings, was considered as the most important constraint to productivity improvement. A producer mentioned that:

“In the aquaculture sector, the cost of raising fish is higher than the cost of selling fish on the market”.

Another constraint is the low market price of imported fish from neighboring countries, competing against Cambodian products in the market and reducing the profit margins for Cambodian producers. Market prices are uncertain and fluctuate depending on the availability of imported products. A producer said:

“... the price is not stable, it declines when the imported fish from Vietnam enters the market. Because whenever it enters the market, our fish prices decrease.”

This relates to an inadequate institutional framework and capacity to regulate cross border trade to control imports of aquaculture products.

The respondents described the level of technology and adoption of new technology as low because of the limited capacity of extension services, and the limited knowledge and reluctance of farmers to adopt new technologies. Water shortages in dry season and contamination of water resources caused by agriculture and industry were also a major concern to the respondents. The months of April and May are difficult for fish farmers, as they often do not have access to sufficient water, or water is polluted from agriculture. A producer mentioned:

“... we cannot pump water from our stream. Why so? Because the Chinese spray chemical substances on cassava and rice which flow into the stream. If we are not careful with that water, our fish would die ”

The main opportunity for the sector is the positive perception of Cambodian consumers about Cambodian aquaculture fish. There is a common belief that Cambodian-farmed fish is of high quality because it is raised using less chemicals compared to imported fish. Consumer preferences (and market prices reflecting these) rank Cambodian aquaculture fish second, behind wild fish. Cambodian consumers also prefer farmed fish sold alive as an indicator of freshness. A wholesaler mentioned:

“Even though we sell our local fish at a higher price, people still buy our fish. Even though imported fish is sold at cheap prices, buyers would not buy it if they knew it was imported”.

Another opportunity is the perception by producers and market actors about high growth potential of *Pangasius* production. This species is considered to be easy to raise, and is popular among farmers. In addition, suitable pellet feed is already available on the market. The fish is versatile and can be processed and sold as a variety of products in addition to sold alive. A wholesaler mentioned:

“Do you know why fish retailers love selling Pangasius? Because when they cannot sell all of them, they can process them into various products. They can process Pangasius into fish paste and salted dried [fish]. They only need to dry them in the sun for a while before they can sell those processed fish. They can process it to fermented Pangasius.”

Pangasius is seen as a key species that can become a model for the development of commercial fish farming and for industrial processing and export. A feed mill manager explained:

"... the market demand for processed Pangasius is pretty high. So, in the next five years we may see more competition on both quality and price of the fish feed in our aquaculture market and I think we may see larger farms in our country".

7.1.2. Constraints and opportunities to developing a traceability and quality control system for aquaculture products

Two constraints emerged from the interviews. First, there is no established regulatory framework to implement sanitary and phytosanitary (SPS) standards and traceability system in the fisheries post-harvest. Second, aquaculture actors generally lack awareness and technical capacity to implement necessary measures even if the standards are enforced. In the post-harvest sector, the fish collectors and wholesalers are not interested in SPS, as it would require them to change the way they operate but would not necessarily result in higher price as reward. The criteria currently applied for assessing fish quality was described by a wholesaler as below:

"...they buy based on the size. Live fish means that fish is good quality. No one questions about fish quality; as long as fish are alive, fat and available in the market, those fish are good"

It appears that a traceability pilot system was initiated in 2010 by FiA and failed due to limited ability of FiA to coordinate different actors of the value chain. SPS guidelines were also drafted but never finalized due to lack of budget and support from development partners, according to a government official. Overlapping roles and responsibilities for monitoring and controlling imported fish products among various government departments added another layer of complication to this challenge.

On the other hand, there is clear need for an SPS system to facilitate the marketing of aquaculture products for both domestic and international markets. Development partners, government officials, feed distributors, and hotel and restaurant representatives all seemed to share this vision. Several HORECA and supermarket managers stressed the need to have a quality control system and that consumers (middle and upper class Cambodians and foreigners) are more aware of food safety issues, and have own system of checking the quality of the aquaculture products they purchase.

Several respondents considered the inability to distinguish between local and imported products as causing missed business opportunity for producers to access markets and gain higher selling prices. A donor representative mentioned QR code technology used in food sector in other countries as a possible solution for improving traceability of the products.

7.2. Program implementation

7.2.1. Barriers to program implementation

For producers, main barriers identified were limited access to water and high cost and/or low quality of inputs. Limited access to sufficient and clean water is a major concern to hatcheries and nurseries for producing quality fingerlings. A nursery operator mentioned:

"Another constraint is the irregular rain that makes fish become sick or die [...] it will make the fish die".

Fingerling quality is limited due to low quality broodfish available in Cambodia. Nurseries or fingerling traders noted that they do not have sufficient skills to assess fingerling quality, or certification scheme assuring the quality and origin of fingerlings.

Pellet feed quality is also uncertain, price tends to be high and local homemade feed used to raise *Pangasius* is of variable quality. A producer explained that:

“In the past there were abundant supplies of fish, but now it has decreased, so if we raise more [fish], the interest rate which applies when we buy trash fish become more expensive. We don’t make much profit from doing that.”

Because of high prices of feed producers limit the use of feed, resulting in low quality of the final product. A wholesaler reports:

“Some producers cannot afford to feed their fish, so the fish become so skinny”

Raising snakehead or *Pangasius* to commercial size requires a long growing period, even longer than one year, which therefore requires a large investment in feed. Many farmers cannot wait for that long and sell their fish before the fish reaches market size. Access to formal bank loans is limited for commercial farms, nurseries and hatcheries, as it requires collateral. In alternative producers borrow money from informal money lenders and/or input providers, to whom they have to sell their produce at below market prices.

Encouraging investment in on-farm infrastructure will be difficult if the farm does not own a secure land title. Producers renting land are reluctant to invest in hard infrastructure, such as a deep well. In addition, program implementation, at producer level and also within post-harvest segment, will face strong competition from cheap imported fish popular amongst the rural population because of its affordability. A fish farmer said:

“The problem is that a lot of Pangasius [I raised] remains [unsold] since there are a lot of imported fishes from Vietnam. A lot of imported fish from Vietnam entered [Cambodia] recently, so the local fish prices declined.”

Limited access to water limit flexibility in cropping calendar and local fish farmers often sell their product at the same time as others do, saturating local supply and thus reducing market prices. This also mean that there are seasonal gaps in the availability of locally produced fish, which have to be filled with imported fish. Wild fish, as the first choice of local consumers, also compete on the same market albeit in much higher price range than farmed fish. In addition, local producers and processors are not able to meet the quality and volumes required for export markets. The procedures required to export fish products are perceived to be very complicated and unclear by the respondents.

7.2.2. Facilitators to program implementation

Currently producer and value chain networks are informal and based on personal relationships. A more formal information-sharing network can be facilitated by digital technology, as some actors already access on-line information. A feed distributor said:

“I think that I have enough, since I can access a smart phone and the internet. I can search for all the information that I need such as prices and sources of products. I can also call suppliers and customers from my phone if I need to.”

FiA officers recognize that the extension services provided by the government are inadequate, and that the government needs private sector, producer associations, and NGOs to fill these gaps. Some input suppliers have already been providing technical support to producers as a strategy to attract more clients. A feed distributor – hatchery mentioned:

“I would bring the complete set (technical support, fish health, and fish feed) along with fingerlings to producers.”

Some farmers and hatcheries also show willingness to try new approaches and thus have high potential for becoming model farmers. They have acquired technical skills through trial and error, without external assistance. A hatchery owner mentioned:

“...I still wonder how they [Vietnamese fish farmers] can raise the fish to grow well but we can't? So I had to try it by myself. Passion has pushed me to raise more fish.”

A nursery operator mentioned:

“For everything, if we take good care of it, it won't fail. Like my husband and I, when we started to [produce fish] for the first time, a lot of fingerlings died. But I sought strategies which can save fingerlings and reduce the fingerlings' mortality rate.”

7.3. Services and support needed for beneficiaries' success

A common theme that emerged was the need for formal training and extension services. A majority of interviewees who derive livelihoods from aquaculture responded that they have never received any formal training and/or support from donor or government projects at all. The producers responded:

“I want to have frequent training and want them [CAST project] to show me which medicine to treat fish, teach me to diagnose fish and provide medicine that can treat our fish.”

Another common theme was the need for better coordination and access to information and knowledge for different actors of the value chain. It was suggested that CAST support an association or platform to support more transparent information exchange within a sector, which has remained rather secretive so far. A platform or association could help in facilitating discussion with the government to request regulation on import of fish and facilitate the diffusion of improved management practices. A potential CAST partner suggested that the project support the development of a niche market for quality fish, stimulating the demand for higher value fish:

“If we convince the restaurants and the hotels to really purchase those good quality (fish) compare to the normal one, I think it might be also an option that we can increase the demand for the producers, specifically those who adopt specific good practices”

Another identified theme is the need to access loans at lower interest rates. Fish farmers, especially those who live in floating villages, take loans from private money-lenders because they have no other option. A producer said:

“Right now, we can take loans from certain clients. For example, we may be able to take a loan for a sum of USD 2,000 to 3,000; but when harvesting and selling the fish, we have to pay it back. The total interest is more than the principal that we borrowed.”

The respondents expressed needs for services and support similar to the constraints described earlier emphasizing the need to access quality inputs and loans, and for improved market governance and competitiveness of local product as well as coordination along the value chain.

7.4. Relationship building

We identified two main themes related to relationship building: i) the need for an aquaculture association and; ii) the need for improved trust and connection between actors.

Thanks to various donor projects supporting aquaculture development in the past, there are informal networks currently operating at national and provincial level, none of them

formalized. As mentioned in the previous section, actors highlighted the need to have a formal platform to share information among the various actors of the value chain. Feed mills and distributors, hatcheries, nurseries and hotels and restaurants, all expressed interest in the development of an association because it will facilitate transparency in information sharing among all stakeholders. Fish producers are also keen to see an association providing both technical guidelines on aquaculture production and information about market demand and updated market prices, sources of quality seed, feed and medicine. Restaurant owners see the association as a “control” system related to quality standard:

“When they [producers] join the association, they will gain more knowledge on how to raise the fish properly, so it won’t affect the health of the customer. If they are not under control of the association, they can do whatever they want with the fish by feeding it with chemical substance to make it grow abnormally.”

Trusted relationships can take different forms: providing technical recommendations when inputs are sold (feed, fingerlings), a technical follow-up of a client’s production. Trusted relationships also exist in the form of ‘business partnerships’ between feed suppliers and fish producers, producers and fish collectors, and feed mills and feed distributors. A producer explained:

“I trust the middleman. We do business together for almost two decades. For example: when the truck arrives, the middleman called me, they told me the fingerlings for this time are good quality. I go and collect that fingerlings from them and share with my fellow farmers here.”

A hatchery owner explained his relationship with clients as below:

“I’ve been doing fingerling business for 15 years in here. For the old customers who take the fingerlings from me, they don’t run off although my price of fingerlings is a bit expensive, they still buy fingerlings from me because they trust me that I never cheat them.”

Those relationships are based on many years of working together but can be jeopardized easily. Distrust of inputs suppliers can hinder adoption of new technologies or practices. For instance, some producers did not receive good quality fingerlings from fingerling traders or nurseries as they were promised, as illustrated in a statement of a fish producer:

“In Phnom Penh, there are some places that sell fingerlings too, but those places might cheat the farmers.”

Building trusted relationships and improving connections between actors is essential to developing and expanding commercial aquaculture in Cambodia. More open information-sharing on price and economic return, including the use of on-line tools, and facilitating interaction among actors, can increase transparency and trust in the value chain. This also applies to MFIs and their need to better understand the sector.

8. KEY FINDINGS

This section summarizes the key findings of the CAST baseline evaluation and provides recommendations for project design, implementation, and the monitoring and evaluation system.

8.1. Aquaculture production and quality

The baseline survey results show that both ponds and cage aquaculture are dominant forms of commercial aquaculture production in Cambodia. Productivity performances are sub-optimal for the area cultivated due to low stocking density and the absence of aeration or proper water management practices. Productivity is hindered by low quality inputs, specifically fingerlings of un-known origin. Production systems found in the surveyed provinces are not diverse, with *Pangasius* and giant snakehead being the most commonly farmed fish in all the main producer clusters, using similar management practices.

The consequences of these combined constraints on productivity cannot be overstated. As a stark comparison, the average productivity in pond culture of *Pangasius* in Cambodia achieves less than 25% of a similar system in Vietnam⁵², in terms of kg/m².

There are significant differences in terms of production systems, volume, and level of management practices across provinces in Cambodia. This indicates that the current low productivity and lack of diversification is a function of limited input supply and knowledge gaps, rather than the production capacity of the farms themselves. Thus, the potential for increasing both the quantity and quality of fish from existing aquaculture producers is high.

The productivity of the aquaculture producers has not reached its potential because they do not have access to quality fingerlings, reasonably-priced feed, or technical knowledge to improve management practices. Hatcheries operate at low performance levels, and nurseries operate as traders of imported fingerlings, rather than acting as intermediaries between domestic hatcheries and producers in Cambodia. The competition with cheap imported fingerlings is the biggest challenge the hatcheries in Cambodia face, and discourages these operators from investing in better infrastructure and management practices to improve productivity. However, with relatively simple improvements in the handling of fish and business management, hatcheries can improve their performance significantly. For the local hatcheries to become competitive in the market, major long-term investments in the sector's development, such as the introduction of improved strains of farmed fish and domestication of local high-value fish species, need to be considered.

Commercial fish feed production in Cambodia is still at a developmental stage, and is likely to take a few years before it can be fully operationalized. Thus, the feed supply will continue to rely on imported products for the foreseeable future. However, the feed producers that are conducting their own experiments into fish feed need technical and financial assistance to develop new product lines that can eventually enter the market. The feed producers are already using soybeans from various sources, including the U.S., as animal feed ingredients. It is unclear whether they make deliberate choices in terms of the source of imported soybeans. To encourage the use of soybeans from the U.S., it is important to understand the local demand, likely influenced by prices, timing and availability, and procurement process. CAST may consider facilitating direct business relation between local feed mills and U.S. exporters and traders to facilitate mutual understanding of the needs of local feed mills and logistical and administrative requirements.

⁵² http://www.fao.org/fishery/culturedspecies/Pangasius_hypophthalmus/en

Formal loans from micro-finance institutions have high interest rates that are prohibitive to small and medium-scale operators with limited profit margins. Consequently, producers often subscribe to in-kind loans from input suppliers in the form of farm inputs, which may have resulted in insufficient use of inputs for boosting farm productivity. The study results show a higher rate of commercial pellet feed is associated with access to loans and/or training from previous donor/NGO projects. With improved access to financial and technical assistance, the producers may gain more confidence to invest in improved feed and feeding regimes.

The CAST Activities #1, #2, #3, #4, and #10⁵³ will address these challenges by upgrading extension services and access to knowledge to the producers and input suppliers, and demonstrating improved management practices through model farms. In implementing these activities, we recommend CAST to:

- Focus the project interventions initially on existing producer clusters in selected locations and key species, i.e. *Pangasius* and snakehead, and use an “incremental innovation approach” to gradually upgrade management practices of producers, particularly feeding. For example, providing alternative feed for snakehead producers when the supply of trash fish is low would give an opportunity for the producers to test pellet feed and encourage them to reduce the unsustainable use of trash fish.
- Focus its technical intervention initially to support a large number of pond-based producers who can improve productivity through relatively simple changes in water management and pond preparation. These elements of the aquaculture practices can be easily improved (using lime, fertilizer) without significant investment cost and support an increase in productivity. This type of technological package needs to go in parallel with an improvement in feeding regimes.
- Develop Best Aquaculture Management Practices (BAqMP), guidelines⁵⁴, that can later inform the future national BAqMP to be developed by the Fisheries Administration. A general *Pangasius*⁵⁵ BAqMP already exists but needs to be adapted to the local context. BAqMP for snakehead and giant snakehead species currently do not exist; developing a progressive BAqMP for two commonly-farmed snakehead species would enable quality improvements in Cambodia, and could become the basis for a future national snakehead BAqMP.
- Develop model farms, including both ponds and cages, to demonstrate improved production techniques as well as effective business models. A wide range of technologies and practices need to be demonstrated, including feeding practices, fingerling selection, water management, and fish disease control. The demonstration farms need to be nested within existing hatcheries and nurseries networks where the role of feed distributors, hatcheries, and nurseries as private extension services can also be enhanced and serve as a model for replication in other locations.
- Apply an integrated approach to address financial and technical obstacles simultaneously throughout the production and post-harvest value chain. For example, packages of support, combining upgrades in production techniques with an improved business model and marketing strategy, can result in higher profit margins and a more

⁵³ Activity #1: Capacity Building: Agricultural extension agents/services; Activity #2: Inputs: Develop agro-dealers and/or other input suppliers; Activity #3: Training: Improved farm management; Activity #4: Training: Demonstration plots; Activity #10: Financial Services: Provide SME finance, technical assistance loans and grants

⁵⁴ Best Aquaculture Management Practices (BAqMP) are recommended practices by the industry and/or institution such as Food and Agriculture Organization, National Oceanic and Atmospheric Administration (NOAA) or ASEAN community. A multitude of guidelines and manual exist detailed at the species level.

⁵⁵ https://www.asc-aqua.org/wp-content/uploads/2017/07/ASC-Pangasius-Better-Management-Practices_v1.01.pdf

rapid recovery rate of the investment cost. In this approach, the emphasis should be on improving the quality and market value of farmed fish, rather than simply increasing production volume.

- Support MFI and insurance companies to gain an improved understanding of aquaculture-related businesses and assess their financial performance and lending risks. Supporting the aquaculture producers to develop good business plans can increase the confidence level of financial institutions sufficiently to offer lower interest rates through specialized lending programs.
- Support climate change adaptation by identifying key communes and districts where access to water is a constraint and/or ponds are frequently affected by flooding. The adoption of short cycle species is not yet common in Cambodia. In these specific areas the project should develop a “climate smart business model” based on short cycle species.

8.2. Value chain efficiency

Demand for quality aquaculture fish produced in Cambodia is high and increasing, but the current production level and the capacity of local producers is too low to meet this demand. Aquaculture fish produced in Cambodia currently represents 54% of the volume traded by the collectors and wholesalers surveyed by the study, while capture fisheries and imported aquaculture fish make up the rest. Consumer preferences in Cambodia rank capture fish the highest, aquaculture fish from Cambodia the second, and imported aquaculture fish the lowest; however, there is no system to clearly distinguish the origin and assure the quality of these products when it reaches the consumer market. Reliable mechanisms for improving traceability and quality standard such as third party certification, or “block-chain” mechanisms involving digital technology need to be established and can create premium prices for products that meet certain consumer preferences and market niches. Aquaculture fish can fetch the highest prices when sold alive. Thus, hygienic standards and fish handling/transportation technologies of post-harvest operators need to be improved as a priority, through the provision of suitable equipment and procedures.

Fish buyers and traders are often the only source of market information for producers, and thus have a distinct advantage in the value chain, over the producers. There is no information sharing mechanisms at provincial or national levels to facilitate access to reliable and up-to-date information on aquaculture inputs and product prices. Many producers are also tied to particular buyers through debt. Breaking the cycle of these patron-client relationships, which are very common in Cambodia and are often built on long-term personal relationships, is challenging. However, improved access to other financial services and alternative models of trading and marketing can improve the negotiating position and profit of producers in the value chain.

9. RECOMMENDATIONS

9.1. Aquaculture production and quality

The CAST Activities #1, #2, #3, #4, and #10 will address challenges related to aquaculture production and quality presented in section 8.1, by upgrading extension services and access to knowledge for producers and input suppliers, and demonstrating improved management practices through model farms. In implementing these activities, we recommend CAST to:

- Focus the project interventions initially on existing producer clusters in selected locations and key species, i.e. Pangasius and snakehead, and use an “incremental innovation approach” to gradually upgrade management practices of producers, particularly feeding. For example, providing alternative feed for snakehead producers when the supply of trash fish is low would give an opportunity for the producers to test pellet feed and encourage them to reduce the unsustainable use of trash fish.
- Focus its technical intervention initially to support a large number of pond-based producers who can improve productivity through relatively simple changes in water management and pond preparation. These elements of the aquaculture practices can be easily improved (using lime, fertilizer) without significant investment cost and support an increase in productivity. This type of technological package needs to go in parallel with improvements in feeding regimes.
- Develop own Best Aquaculture Management Practices (BAqMP) guidelines, that can later inform the future national BAqMP to be developed by the Fisheries Administration. A general Pangasius BAqMP already exists but needs to be adapted to the local context. BAqMP for snakehead and giant snakehead species currently do not exist; developing a progressive BAqMP for two commonly-farmed snakehead species would enable quality improvements in Cambodia, and would become the basis for a future national snakehead BAqMP.
- Develop model farms, including both ponds and cages, to demonstrate improved production techniques as well as effective business models. A wide range of technologies and practices need to be demonstrated, including feeding practices, fingerling selection, water management, and fish disease control. The demonstration farms need to be nested within existing hatcheries and nurseries networks where the role of feed distributors, hatcheries, and nurseries as private extension services can also be enhanced and serve as a model for replication in other locations.
- Apply an integrated approach to address financial and technical obstacles simultaneously throughout the production and post-harvest value chain. For example, packages of support, combining upgrades in production techniques with an improved business model and marketing strategy, can result in higher profit margins and a more rapid recovery rate of the investment cost. In this approach, the emphasis should be on improving the quality and market value of farmed fish, rather than simply increasing production volume.
- Support MFI and insurance companies to gain an improved understanding of aquaculture-related businesses and assess their financial performance and lending risks. Support the aquaculture producers to develop good business plans can increase the confidence level of financial institutions sufficiently to offer lower interest rates through specialized lending programs.

Support climate change adaptation by identifying key communes and districts where access to water is a constraint and/or ponds are frequently affected by flooding. The adoption of short cycle species is not yet common in Cambodia. In these specific areas the project should develop a “climate smart business model” based on short cycle species.

9.2. Value Chain efficiency

The CAST Activity #5, #6, #7, #8 and #9 will provide training and capacity building to beneficiaries operating in the post-harvest value chain to upgrade value chain efficiency challenges identified in section 8.2. In implementing these activities, we recommend to:

- Enhance and expand existing network of hatcheries/nurseries and producer clusters to include post-harvest operators, improve the quality and flow of new knowledge and technology, and market information to the producers, and demonstrate a more transparent and equitable value chain.
- Improve business management practices at an individual farm and business operator level to promote self-sufficiency, and avoid overreliance on external subsidies. The project should develop locally adapted tools and training material to increase the adoption of basic business management practices such as recording inputs and sales, but also develop business plans such as identifying market in advance.
- Hygiene practice is low for a large number of value chain actors. Training and raising awareness of hygiene practices will not lead to sustained behavior change without clear financial benefit for the wholesalers, collectors and processors. Therefore, the project should already identify markets for higher quality fish and fish products, before engaging training. This way, the newly identified buyers of the higher quality produce, can be a part of the new value chain arrangements, including the training needs. Training for higher hygiene and quality, as well as traceability systems (see below) should be demand driven.
- Improved post-harvest and marketing practices should focus on key species (*Pangasius* and snakehead) and product (dry and smoked fish) and also include fish sold alive fish which represent a large volume of the production. For the latter, current practices are not well known and identification to improve performance and quality of this sub-value chain should be a priority.
- Alternative contractual arrangements are facilitated between producers and buyers, such as group contracts, and pricing systems, such as collective marketing and/or auctioning of farmed fish. Auctioning can contribute to the development of price premium for locally produced fish. These will also require behavioral changes regarding some traditional business habits such as contracting some days before harvest. Buyers can also benefit by reducing their business risk through securing supply volume and timing through group contracts.
- Adoption of improved management practices at the producer level, which requires a higher investment, will be effective and sustainable if driven by market demand and requirement of the buyers. Therefore, the project should focus activities and interventions in the identified processing “hubs” to create demand for higher quality products and link those with farmer clusters.
- Support on traceability and SPS mechanisms should initially focus on a limited number of commodities or products as a pilot, that are already linked with a relatively well-organized value chain, to major consumer markets in urban areas. *Pangasius* or giant snakehead are good examples. Using the pilot product value chain, an awareness campaign could be developed in urban centers to build demand for high quality, locally raised fish. Subsequent stimulation of demand for locally-raised, high quality fish can catalyze the demand for other fish and fish products, generate premium prices for these products, as well as incentives for producers and post-harvest actors to improve management practices.
- Develop an SPS scheme for CAST, in line with existing SPS in the aquaculture industry in Southeast Asia, and start testing the implementation in collaboration with the Cambodian

government and private sector. By so doing, CAST can contribute to the development of SPS system by the Cambodian government which will likely begin during the life of the project.

- Some value chain actors have limited access to formal finance investment loans in infrastructure, due to lack of collateral (e.g., land title). Providing support to these beneficiaries to develop robust business models and plans can facilitate improved access to formal loans.

9.3. Design of Monitoring and Evaluation system for CAST

Two types of M&E activities are to be expected: 1) generation of Standard and Custom indicator values to be reported to USDA at required frequency and scope (IPTT); and 2) activity tracking and progress monitoring for the CAST management. It is impractical to replicate the entire suite of baseline surveys on a yearly basis. We recommend that only a subset of surveys are replicated on a yearly basis (or 6 monthly, depending on required frequency) to generate indicator figures, using purposive sampling.

The number of Standard and Custom indicators in CAST IPTT, and the level of disaggregation seems quite ambitious for a project of this size and scope. Setting realistic annual targets for all the indicators (with proposed disaggregation) would require substantial effort and additional research to develop assumptions and growth scenarios. For the purpose of reporting to USDA our suggestion to CAST is to prioritize a smaller number of key indicators that best represent high level outcomes that CAST aims to achieve within the life of the project.

Simplification of some Standard Indicators, by reducing the level of disaggregation, can also be considered to enable annual reporting based on the scope and geographic coverage of actual project interventions each year. Annually assessing the yields of several different types of production systems, such as pond and cage systems, and several species of fish, through population-based surveys will be time consuming, and difficult to compare the project impact on an annual basis. To develop a practical M&E system we suggest a smaller, purposive sample size to monitor production system performance of the beneficiaries who received assistance in a given year more precisely. For example, Standard indicator #1: Yield of targeted agricultural commodities among program participants with USDA assistance, can focus on selected fish or products in the geographic areas where the project activities are actually implemented. Reporting incremental increases in the volume of production and sales can also be simplified by focusing on specific time of the year, with bulk of harvest taking place within a few-months period in a year, rather than reporting annual total volume. Similarly, stocking of fish should be concentrated within a few months. Resources affected by track and monitor activities should acknowledge those peak periods.

The tracking and progress monitoring activity needs to follow up on direct beneficiaries who receive project support in a given year. Detailed monitoring will be useful for model units on individual farms that have more than one production unit (pond or cage), to capture seasonality, with additional performance indicators of production system such as feed conversion rate (FCR) that requires detailed information from individual farmers. In order to inform project activities and develop locally sustainable business models for producers and other beneficiaries, financial and activity logbooks should be kept, at least for fish producers to: i) estimate net income gain; and ii) assess feasibility for production upgrade. This level of monitoring, ideally, should be supported for all individual farms that receive project assistance, for the purpose of project management.

Some Custom indicators require determination of “improvements” in management practices and technologies, or quality standard, applied by the project beneficiaries, and reported as a number of individuals/firms or hectares/square meters. These indicators may be more suited for progress monitoring through activity tracking, than population-based survey. Similarly, reporting on Standard indicator #2: Number of hectares under improved management practices or technologies that promote improved climate risk reduction and/or natural resources management with USDA assistance and Standard indicator #3: Number of hectares under improved management practices or technologies with USDA assistance, can be done more effectively through activity tracking and record keeping conducted by field staff of CAST, rather than survey.

We recommend CAST to conduct case studies with a selected number of beneficiaries to assess individual farmers’ progress against some of the variables that constitute the index of “improved management practices” related to Standard #3, Standard #4 and Custom #2 indicators.

10. CONCLUSION

Findings of the CAST Baseline Evaluation were consistent with other recent review and value chain studies of the sector (VCA4D; NSPAD 2017). The sector is dependent on imports for inputs, the practices and performance of the sector are sub-optimal. The value chains are inefficient, neither vertically nor horizontally integrated, and are characterized by limited contracting practices, marketing and market channels based on personal networks, and lack of transparent information sharing.

Therefore, various CAST sub-activities need to be implemented in a coordinated manner to achieve performance improvements in productivity and quality of producers at the same time as the improvements in access to market and profitability. Higher profitability and a more secure market can trigger changes in the behavior of producers towards the adoption of improved production and business practices.

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ANNEXES

- A. Request for proposals (RFP) to conduct a baseline evaluation for ASA/WISHH's Food for Progress (FFPr) Program in Cambodia
- B. Sampling Framework
- C. Questionnaires & Survey Tools
- D: Standard and custom indicators (summary tables)
- E: List of key informants
- F: Additional result tables for baseline research question and key findings
- G: Co-variates analysis
- H: List of consulted documents
- I: Additional results from the qualitative study

ANNEX A: REQUEST FOR PROPOSALS (RFP) TO CONDUCT A BASELINE EVALUATION FOR ASA/WISHH'S FOOD FOR PROGRESS (FFPR) PROGRAM IN CAMBODIA



Commercialization of Aquaculture for Sustainable Trade (CAST) Cambodia

Request for Proposals (RFP) to Conduct a Baseline Evaluation for ASA/WISHH's Food for Progress (FFPr) Program in Cambodia

Overview

RFP NUMBER: FFPR18-RFP-01-2018

RFP ISSUANCE DATE: January 14th, 2019

QUESTIONS DUE: January 25th, 2019 – 5:00 PM CST

PROPOSALS DUE: February 11th, 2019 – 5:00 PM CST

The American Soybean Association's (ASA) World Initiative for Soy in Human Health (WISHH) program is posting this Request for Proposals (RFP) for a consultant to conduct the Baseline Evaluation, hereafter referred to as the Baseline Study, under the Food for Progress (FFPr) 2018 Project funded by the United States Department for Agriculture (USDA) and Implemented by the Commercialization of Aquaculture for Sustainable Trade (CAST) project in Cambodia.

ASA/WISHH invites proposals to be submitted electronically on or before the date and time specified above. Submissions should be sent via email to James Bernhardt at jbernhardt@soy.org (cc: arolo@soy.org).

All submissions should identify the RFP number: FFPR18-RFP-01-2018 and the name of your organization in the subject line.

RFP Conditions

Award: This RFP does not commit the ASA/WISHH to award a contract or to pay any costs incurred in the preparations or submission of proposals, or costs incurred in making necessary studies for the preparation thereof or to procure or contract for services or supplies. The ASA/WISHH reserves the right to reject any or all proposals received in response to this RFP and to negotiate with any of the vendors or other firms in any manner deemed to be in the best interest of the ASA/WISHH. The ASA/WISHH reserves the right to negotiate and award only a portion of the requirements; to negotiate and award separate or multiple contracts for the elements covered by this RFP in any combination it may deem appropriate, at its sole discretion to add new considerations, information or requirements at any stage of the procurement process, including during negotiations with vendors; and reject proposal of any vendor that has previously failed to perform properly or in a timely manner contracts of a similar nature, or of a vendor that, in the opinion of the ASA/WISHH, is not in a position, or is not sufficiently qualified, to perform the contract.

This RFP contains no contractual proposal of any kind, any proposal submitted will be regarded as a proposal by the vendor and not as an acceptance by the vendor of any proposal by the ASA/WISHH. No contractual relationship will exist except pursuant to a written contract document signed by the authorized procurement official of the ASA/WISHH and by the successful vendor(s) chosen by the ASA/WISHH.

Submission of Questions: All questions regarding the preparation of proposals must be submitted in writing (by e-mail) to James Bernhardt at jbernhardt@soy.org (cc: arolo@soy.org) **no later than 5pm CST on Friday, January 25th, 2019**. A copy of all written questions and responses will be provided to all interested organizations by email request on or shortly after Monday, January 28th, 2019. No questions will be answered over the phone or in person; all questions must be in writing and sent via email.

Guiding Principles: Consultants must conduct all activities for the Baseline Study in an ethical manner. Evaluation activities should appropriately balance the desired creation of evidence with the protection of human subjects, including safeguarding the dignity, rights, safety, and privacy of participants. Evaluators are responsible for applying ethical principles in all stages of the Baseline Study, and for raising and clarifying ethical matters with stakeholders during the course of the Baseline Study.

Conflict of Interest: All team members must provide a signed statement attesting to a lack of conflict of interest, or disclosing any real or potential conflicts of interest.

Non-Discrimination Statement: ASA/WISHH prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation or all or part of an individual's income is derived from any public assistance program or activity conducted.

Table of Contents

Table of Contents.....	3
Acronyms and Abbreviations	4
List of Figures.....	4
List of Tables	4
Section 1: Supplies or Services and Prices/Costs.....	5
1.1 Purpose	5
1.2 Period of Performance	5
Section 2: Background.....	5
2.1 About the Organization.....	5
2.2 Project Description	6
2.3 Relevant Program Documents.....	10
Section 3: Statement of Work	10
3.1 Baseline Study Objectives.....	10
3.2 Baseline Study Questions	11
3.3 Approach and Methodology.....	12
3.4 Deliverables	12
Implementation Plan and Schedule.....	12
Data Analysis Plan.....	13
Baseline Study Report and Baseline Data.....	13
3.5 Research Team.....	15
Attachment A: Proposal Guidelines and Selection Criteria	17
Attachment B: Abbreviated Version of PMP with Standards.....	18
Attachment C: Abbreviated Version of IPTT with Customs	27
Attachment D: Project-Level Results Framework(s).....	28
Attachment E: Project Implementation Map.....	29

Acronyms and Abbreviations

ASA	American Soybean Association
CAST	Commercialization of Aquaculture for Sustainable Trade
CE SAIN	Center of Excellence for Sustainable Agricultural Intensification and Nutrition
FAS	Foreign Agricultural Service
FFPr	Food for Progress
IPTT	Indicator Performance Tracking Table
KII	Key informant interview
KSU	Kansas State University
LOP	Life of project
M&E	Monitoring and Evaluation
MAFF	Ministry of Agriculture, Forestry and Fisheries
MES	Monitoring and Evaluation Staff
PMP	Project Monitoring Plan
PSM	Propensity score matching
QDA	Qualitative data analysis
RFP	Request for Proposals
SME	Small- to medium-sized enterprises
SPS	Sanitary-phytosanitary
TBD	To be determined
TOR	Terms of reference
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USG	United States Government
WISHH	World Initiative for Soy in Human Health

List of Figures

Figure 1: USDA Results Framework with CAST Activities (SO1)

Figure 2: USDA Results Framework with CAST Activities (SO2)

Figure 3: Map of CAST-targeted geographies

List of Tables

Table 1: Timeline for Baseline Study

Table 2: Final Report Requirements

Table 3: Criteria for Scoring Proposals

Table 4: Overview of Standard Indicators

Table 5: Overview of Custom Indicators

Section 1: Supplies or Services and Prices/Costs

1.1 Purpose

The purpose of this RFP is to solicit applications from companies and/or individuals to conduct a Baseline Study for ASA/WISHH's CAST project in Cambodia. CAST is a five-year USDA-funded project that was awarded in September 2018. The Baseline Study will collect quantitative and qualitative baseline data to be included in the project's Performance Monitoring Plan (PMP) and Indicator Performance and Tracking Table (IPTT). Additionally, this exercise will allow ASA/WISHH to eventually assess the extent to which project objectives were met or unmet over the life cycle of the project.

The Baseline Study team will be comprised of the lead consultant and his/her assistants, and shall work in cooperation with USDA's Monitoring and Evaluation Staff (MES) in Washington, D.C., ASA/WISHH's M&E Officer based in St. Louis, Missouri, CAST's Chief of Party and M&E Manager based in Cambodia, and CAST's implementing partners in Cambodia.

1.2 Period of Performance

The Period of Performance of this contract is expected to fall between March and August 2019. The anticipated award date for this contract is March 1st, 2019. The final report should be submitted to ASA/WISHH on or before August 5th, 2019. Please see Table #1 for more details about the proposed timeline for the Baseline Study.

Section 2: Background

2.1 About the Organization

The American Soybean Association (ASA) was founded in 1920 by soybean farmers and extension workers to promote soy for high protein applications in developmental settings. Overseas activities initiated in the mid-1950s and to date ASA has worked in over 80 countries. The World Initiative for Soy in Human Health (WISHH) was founded in 2000 to expand the work of the American Soybean Association (ASA) in developing emerging markets to improve health, nutrition and food security—building the groundwork for future markets of soy. WISHH provides services in food technology, business development, nutrition services, and program and proposal development. WISHH expertise extends its network into additional areas, such as aquaculture and animal feed.

ASA/WISHH connects trade and development to strengthen agricultural value chains in emerging markets, creating trade and long-term demand for U.S. soy. Trade can improve lives worldwide for both farmers and consumers. U.S. soy trade in emerging markets is pivotal to improve accessibility, affordability, and acceptability of high-quality plant and animal-sourced proteins in developing economies. Rising incomes in emerging economies generate further opportunity for trade. ASA/WISHH builds opportunity for long-term trade by improving agricultural value chains, human and animal nutrition, and farmer net incomes. ASA/WISHH initiatives broadly fit in two arenas: (1) trade-building long-term, early-stage market development, and, (2) trade-building international agriculture and economic development. The St. Louis-based Program operates in sub-Saharan Africa, Asia and Central America.

ASA/WISHH has supported market and economic development activities in the human food sector since its inception in 2000 and works to increase the use of quality soy protein ingredients and products in food for human consumption through commercial development and nutrition programming. ASA/WISHH offers over six years of proven feed sector capacity and decades of accumulated knowledge from ASA programs. Principal approaches include market and economic assessments, technical assistance and capacity building, food and feed trials and demonstrations, farmer field days, youth mentorship programs, food and feed value chain development, and market linkages.

ASA/WISHH achieves its mission by working in close partnership with: (1) the public sector (e.g., USDA, USAID, U.S. land grant universities, and host country governments), (2) the private sector (e.g., trade associations: Qualified State Soybean Boards and U.S. Soybean Export Council), and (3) private voluntary organizations. The Program draws upon the resources and experience of these partners and the services of a cadre of ASA/WISHH consultants with technical expertise in agricultural, international and commercial development spheres.

ASA/WISHH relies on decades of experience in food commercial development and agricultural development programming. The Program takes pride in its growing portfolio of success with U.S. government-funded projects, including USDA (Food for Progress, McGovern-Dole, Global Broad-Based Initiative, Foreign Market Development, Market Access Program, Emerging Markets Program, and Quality Samples Program) and USAID funding in both prime and sub-recipient capacities. ASA/WISHH has also attracted both private sector and other complementary funding sources from various donors to build on and leverage core funding from Qualified State Soybean Boards.

2.2 Project Description

CAST Cambodia is a five-year program financed by the USDA and implemented by ASA/WISHH signed by both parties on September 27th, 2018. CAST's operational budget consists of \$15.55 million in monetization proceeds plus \$1.62 million in CCC funds. The M&E budget for this program is \$2.08 million or 12.1% of the total project budget. The project supports the USDA FFPr objectives of increased agricultural production and trade by increasing the use of improved agricultural techniques and technologies among target populations and improving linkages between buyers and sellers.

The two main objectives of CAST Cambodia are:

1. Increase agricultural productivity in the freshwater aquaculture industry through improved inputs and practices; and
2. Increase trade in Cambodian aquaculture, by volume and value.

These objectives will be supported by the following activities:

Activity #1: Capacity Building: Agricultural extension agents/services

ASA/WISHH will build the capacity of Cambodian aquaculture education and extension systems through the transfer of U.S. agricultural research and extension methodologies. ASA/WISHH will

conduct needs assessments with stakeholder groups to determine technology gaps, and develop training agendas for conducting capacity building activities. ASA/WISHH will also support the establishment of an aquaculture professional course and certification for university students and professionals, and will institute an internship/mentorship program to pair aquaculture students with industry professionals.

Furthermore, ASA/WISHH will support the Center of Excellence for Sustainable Agricultural Intensification and Nutrition (CE SAIN) to establish aquaculture training and feed demonstration facilities.

Activity #2: Inputs: Develop agrodealers and/or other input suppliers

ASA/WISHH will increase supply and improved access to quality, domestically-produced aquaculture inputs by providing targeted technical assistance to private hatcheries. ASA/WISHH will work to develop aquaculture small to medium-sized enterprises (SME), including seed, feed, and veterinary supplies. ASA/WISHH will conduct an assessment of the seed value chain to assess technical needs, supply chain challenges, and barriers to capacity extension. Through this assessment, ASA/WISHH will provide technical assistance to private hatcheries and feed mills, develop a local aquaculture feed database, and support the development of aquaculture feed formulations. Furthermore, ASA/WISHH will work on the development of aquaculture feed standards in collaboration with the Ministry of Agriculture, Forestry and Fisheries, and support participation of freshwater aquaculture actors in local trade promotional events.

Activity #3: Training: Improved farm management

ASA/WISHH will work with large and medium-sized intensified pond and cage operations in order to increase their productivity and profitability by addressing issues related to technical knowledge and access to quality inputs, including feed, seed and fertilizer, and aquaculture infrastructure. ASA/WISHH will provide technical assistance to SME aquaculture producers and link input supplies to potential buyers.

Activity #4: Training: Demonstration plots

ASA/WISHH will establish model aquaculture and training hubs. This research demonstration site will serve as a hub for expertise on freshwater aquaculture information, training and applied research in aquaculture. ASA/WISHH will work with key stakeholders to develop a technology park's facilities into a primary location for showcasing proven aquaculture research and training.

Activity #5: Training: Sanitary and phytosanitary standards (SPS)

ASA/WISHH will support private sector actors to develop voluntary standards based on the Government of Cambodia's proposed sanitary-phytosanitary (SPS) framework and will help

facilitate the transition to the government's final standards. ASA/WISHH will engage with the Government of Cambodia to facilitate standards and measures adopted by the private sector.

ASA/WISHH will develop a communications campaign among value chain actors and consumers to disseminate the benefits of SPS standards to the public. ASA/WISHH will engage with the Department of Fisheries Post-Harvest Technologies and Quality Control to train private sector actors on voluntary industry SPS standards.

Activity #6: Capacity Building

ASA/WISHH will strengthen the business management capacity of aquaculture enterprises, input and service providers, and other value chain stakeholders. ASA/WISHH will provide technical assistance and support identified stakeholders to develop and implement business plans. ASA/WISHH will provide financial support through cost-sharing capital investments to improve market position. Furthermore, ASA/WISHH will establish a technical assistance loan facility to provide revolving loans to SMEs seeking technical assistance.

Activity #7: Capacity Building: Producer groups/cooperatives

ASA/WISHH will organize aquaculture stakeholders, including producers, aggregators, wholesalers, and input suppliers at local and national levels to address issues of common interest, including public policy, development of voluntary standards, information sharing, and general promotion of Cambodian aquaculture to consumers.

ASA/WISHH will facilitate the creation of a Cambodian national aquaculture association. ASA/WISHH will conduct outreach to promote the association, solicit feedback on association services, and identify potential members. ASA/WISHH will facilitate the selection of association leadership and support members to develop the association mission, services, and sustainability strategies. Once formed, ASA/WISHH will facilitate recruitment via member outreach and promotion, and support participation from project stakeholders. Furthermore, ASA/WISHH will train association leadership and staff in marketing and advocacy strategies, and policy analysis.

Activity #8: Training: Improved marketing and branding

ASH/WISHH will raise consumer awareness of high-quality, Cambodian-grown, freshwater aquaculture fish and strengthen buyer-seller linkages along the value chain. ASA/WISHH will organize and launch a consumer awareness and branding campaign targeting consumers, consumer facing companies, and exporters. ASA/WISHH will conduct a market survey on consumers' current perceptions, preferences, purchasing considerations, and identify media contact points. ASA/WISHH will facilitate the identification and prioritization of consumer perceptions, development of behavior change messaging, identification and selection of media, and design of a marketing and branding strategy.

ASA/WISHH will support producers, wholesalers, distributors, and retailers to build a sustainable supply chain for locally-sourced quality Cambodian fish. ASA/WISHH will promote value-chain linkages and branding techniques for advocating locally produced fish. ASA/WISHH will link high-volume domestic buyers and industries with local producers. ASA/WISHH will also identify regional market opportunities for export and assist exporters in finding reliable supply chains of quality fish. ASA/WISHH will facilitate marketing events, including trade shows and discussion panels to support buyer-seller relationships and promote local aquaculture.

Activity #9: Market Access: Facilitate a traceability system for domestic aquaculture

ASA/WISHH will support selected distributors and export companies to pilot a traceability system to support compliance with production and sanitary and phytosanitary standards. ASA/WISHH will identify a cost-effective technology platform and support industry stakeholders to establish effective, business-friendly protocols to be integrated into a traceability software program. Once protocols are established, ASA/WISHH will train stakeholders on traceability protocols and the use of software and equipment. ASA/WISHH will ensure that marketing materials, consumer awareness/branding campaigns, and export promotion initiatives incorporate information about the benefits of traceability to ensure sanitary and phytosanitary standard compliance. ASA/WISHH will co-invest in the operational costs of the traceability system, and train selected participants on operations management and reporting requirements.

Activity #10: Financial Services: Provide SME finance, technical assistance loans and grants

ASA/WISHH will commission and publish a study outlining the business environment, growth potential, and market opportunities in the aquaculture sector, as well as recommendations for financial institutions, the private sector, and other stakeholders and aquaculture initiatives. ASA/WISHH will conduct project seminars, farmer-field days, agricultural exhibitions and other project activities with representatives from key agricultural financing institutions to build relationships with sector stakeholders and leaders.

ASA/WISHH will provide co-investment opportunities in promising aquaculture value chain enterprises. ASA/WISHH will identify a local financial institution to manage co-investment capital, including joint development of investment criteria, return-on-investment hurdles, and sub-sector prioritization. ASA/WISHH will also establish a separate no-interest revolving technical assistance loan fund. Technical assistance loans will enable the provision of technical and business development services needed to grow and expand SMEs.

ASA/WISHH will support a private agricultural insurance provider to collect quality data related to pond and cage production. Additionally, ASA/WISHH will facilitate the insurance product's introduction to the aquaculture value chain via farm visits, access to information including production models, and meetings with stakeholders. ASA/WISHH will work with the private sector to test new insurance products via simulations with a representative sample of producers to improve the design and reach a final product that can be taken to market. By the end of the project period, it

is expected that ASA/WISHH will have facilitated the first underwritten insurance policies for the aquaculture farmers in Cambodia, which will lay the groundwork for expansion and growth to further reduce the risk in commercial aquaculture. The program will be focusing on specific geographic areas. The provinces targeted by the program include: Siem Reap, Battambang, Pursat, Kampong Thom, Kampong Cham, Kandal, and Phnom Penh. These locations were selected not only for their high production potential and opportunity to support expansion of high productivity systems, but also for their proximity to major markets with strong potential to capture future price premiums.

2.3 Relevant Program Documents

The Consultant will be expected to utilize available documents applicable to CAST Cambodia and display a good understanding for USDA's M&E Policy and Indicator Handbook.

Section 3: Statement of Work

3.1 Baseline Study Objectives

ASA/WISHH is seeking the services of a third-party consultant or team of consultants to carry out a Baseline Study for CAST Cambodia in accordance with the terms of reference (TOR) herein. ASA/WISHH anticipates that this study will take place in the provinces mentioned above and that the Consultants will collect control data from other geographically similar provinces (e.g., Kampong Chhnang, Kampong Speu, Takéo).

The Baseline Study is meant to serve the following purposes:

1. To provide baseline data for the PMP and serve as the basis for updating the yearly and life of project (LOP) targets described in the IPTT, and
2. To provide the benchmark for the project's midterm and final evaluations.
3. To provide information to validate and inform the project's interventions.

The Baseline Study must also provide reliable background information and analysis related to the current conditions and realities in the aquaculture sector and overall economic situation in the targeted six provinces and Phnom Penh, with a specific focus on SMEs.

This will necessitate a quasi-experimental design that uses both quantitative and qualitative methods for collecting baseline data. ASA/WISHH expects that the Consultant will collect data from the following partners, stakeholders, and beneficiaries:

- World Vision, Kansas State University (KSU)'s Sustainable Intensification Innovation Laboratory, Auburn University, Foreign Agricultural Service (FAS)
- Ministry of Agriculture, Forestry and Fisheries (MAFF), and the various Cambodian Government offices working in Aquaculture as well as members of EU-CAPFISH led aquaculture sub-working group.
- Feed mills (e.g., AgriMaster/Medivet), aquaculture producers, hatcheries and nurseries, fish processors and buyers, financial institutions

- Middlemen/services providers, retailers/supermarkets, transporters, distributors

While designing the study and creating the methodology for data collection, the Consultant should consider CAST's Project-Level Results Framework described in Attachment D.

3.2 Baseline Study Questions

The Consultant should propose a detailed and reproducible strategy for answering the following research questions:

1. To what extent did the project have an impact on the productivity of feed mills, aquaculture producers, and hatcheries and nurseries?
2. To what extent did the project have an impact on international soy protein trade and the agricultural and fish product trade in Cambodia?
3. To what extent did the project have an impact on the quantity and quality of feed and seed produced for aquaculture producers and its availability and accessibility?
4. To what extent did the project have an impact on the supply of premium quality Cambodian grown freshwater fish (e.g., snakehead, clarias catfish, red tilapia) to the local market?
5. To what extent did the project have an impact on beneficiaries' ability to access finance that is needed for business growth and development?

It is also expected that the Consultant will work with ASA/WISHH staff to further develop these questions. The Baseline Study should also collect baseline data for all applicable indicators included in the PMP. An abbreviated version of this file can be found in Attachment B. Table #4 includes all of the project's 19 standard indicators.

The following are an amended list of standard indicators the project will need reliable baseline data for prior to delivering services to program beneficiaries:

- Number of hectares under improved management practices or technologies that promote improved climate risk reduction and/or natural resources management;
- Number of hectares under improved management practices or technologies;
- Number of individuals in the agriculture system who have applied improved management practices or technologies;
- Yield of targeted agricultural commodities;
- Value of annual sales of farms and firms;
- Volume of commodities (metric tons) sold by farms and firms.

The project also has 11 custom indicators that can be found in Attachment C. The following is a preliminary list of custom indicators the project will need reliable baseline data for prior to delivering services to program beneficiaries:

- Area of ponds under improved management practices or technologies;
- Number of hatcheries or feed mills providing seed or feed that meets international quality standards;
- Number of market actors selling fish who are compliant with national SPS standards or are

using an independent quality seal;

This information will also help the project to conduct proper and accurate monitoring of the program performance and results. Where applicable, the standard and customs indicators should be disaggregated as specified in CAST's PMP.

3.3 Approach and Methodology

Generally, this study should comprise a mix of quantitative and qualitative methods and tools appropriate to the study's research questions. It is expected that both quantitative and qualitative data is provided to support the study's findings. Additionally, even if/when secondary data are available for the Consultant to build on, attempts should be made to obtain primary data with reliable methods to ensure data integrity.

The methods and tools used in the study should include a combination of the following:

Document review: The Consultant will find it useful to reference a broad range of background documents related to the aquaculture sector in Cambodia apart from project documents provided by ASA/WISHH.

Population-based Survey(s): The Consultant will develop and administer one or more population-based surveys to establish baseline values for a number of performance indicators. These surveys will be administered to beneficiaries in each of the project's intervention provinces and a select number of control provinces. A representative sample of beneficiaries should be selected for each of our subgroups and the appropriate survey should be administered to these beneficiaries in person. The Consultant will be responsible for hiring and training enumerators, managing the logistics of field visits, ensuring that the data collected is accurate, and that beneficiary information is safe and secure.

Key Informant Interviews (KIIs): The Consultant is expected to facilitate a limited number of KIIs with key stakeholders, including U.S. and field-based USDA staff, ASA/WISHH staff and associated consultants, implementing partners and staff, and program stakeholders and beneficiaries (e.g., producers, feed mills, hatcheries and nurseries). The purpose of these interviews is to learn more about barriers and facilitators to project implementation and develop a better understanding about the conditions under which CAST will be enacted. The Consultant will need to develop a semi-structured interview guide and propose a strategy for determining which beneficiaries will be asked to participate in these interviews.

If requested, ASA/WISHH will assist in making appointments with partners, community members, government officials and other stakeholders.

3.4 Deliverables

The Consultant is expected to provide the following deliverables to ASA/WISHH:

Implementation Plan and Schedule

The Consultant will submit a draft of their implementation plan on or before the 18th of March.

This document should include the evaluation approach, methods for data collection, overview about data processing and analysis, list of team members' roles and responsibilities, and planned schedule of activities. The final implementation plan should be submitted on or before the 1st of April and include a step-by-step account of how data will be collected and managed during this exercise. This document should also include a detailed schedule of activities and data collection instruments, tools, and guidelines. It is expected that data collection will commence on or around April 15th and be completed within six weeks or by May 27th. The Consultant will complete a desktop review of all data and share a descriptive report with ASA/WISHH on or before June 10th. Data analysis should be completed by June 24th and a first draft of the Baseline Study Report should be submitted to ASA/WISHH on or before July 8th. ASA/WISHH will review this report and provide feedback to the Consultant within two weeks. The Consultant will be expected to review these comments and submit a final copy of this report by August 5th, 2019.

The following table includes important dates for the Baseline Study:

Table 1: Timeline for Baseline Study	
Item	Deadline
First draft of implementation plan	Monday, March 18 th , 2019
Final implementation plan with schedule of activities and data collection instruments, tools, and guidelines	Monday, April 1 st , 2019
Data Analysis Plan	Monday, April 8 th , 2019
Data Collection Phase	Monday, April 15 th – Monday, May 27 th , 2019
Conduct desktop review and complete descriptive report	Monday, June 10 th , 2019
Complete data analysis	Monday, June 24 th , 2019
First draft of Baseline Study Report	Monday, July 8 th , 2019
Final Baseline Study Report	Monday, August 5 th , 2019

Data Analysis Plan

The Consultant will submit a Data Analysis Plan that clearly describes the sampling strategy to be used for the Baseline Study and which includes an overview of how data will be analyzed. The Consultant will also be expected to summarize the methods followed to determine the sample size needed for the intervention and control groups. This document should be submitted to ASA/WISHH on or before April 8th. The Data Analysis Plan should describe what procedures will be used to analyze quantitative data and how the Baseline Study will integrate qualitative data from KIIs with quantitative data from the population-based household surveys. The Consultant will be expected to conduct a theme analysis on this data using approved qualitative data analysis (QDA) software. Each data collection, analysis, and/or presentation tool, including the specific instruments, needs to be approved by ASA/WISHH prior to the start of data collection. The Consultant will administer population-based survey(s) in intervention and control provinces and utilize propensity score matching (PSM) where appropriate. Control data should be collected from producers, feed millers, and other value chain actors who will not receive services in Year 2. This

will allow the project to utilize a stepwise design for a subset of beneficiaries and compare outcomes both within and between clusters of beneficiaries. The Consultant should provide a list of suggested covariates to be collected during this exercise and conduct a confounder analysis if and where possible.

Baseline Study Report and Baseline Data

The Baseline Study Report, not to exceed 30 pages (not including annexes), should be concise and to the point, utilizing charts, graphs and diagrams where appropriate. The Consultant will be required to describe methods used for data collection in enough detail so that the results reported are reproducible. This document should make clear linkages between the data collected and analyzed to key findings reported in the results section of the report. As described, the Consultant will be expected to solicit and incorporate feedback from ASA/WISHH before submitting their final report.

The following table displays requirements for the final report:

Table 2: Final Report Requirements	
<i>Language</i>	ENGLISH
<i>Report Length</i>	<i>Maximum of 30 pages, excluding the Table of Contents and Annexes</i>
Executive Summary	Include a 2-3 page Executive Summary that provides a brief overview of the study's purpose, project background, methods, findings, and lessons learned from the study.
Methods	• Explain study methodology in detail. • Disclose limitations, especially those associated with the methodology (e.g. selection bias, recall bias). NOTE: A summary of methodology can be included in the body of the report, with the full description provided as an annex.
General overview and Baseline Study Questions	Provide a general overview and analysis of the current status in the aquaculture sector in the target areas. Provide answers to the research questions.
Findings and baseline data	Present findings and baseline data as analyzed facts, evidence and supported by strong quantitative or qualitative evidence and not anecdotes, hearsay or peoples' opinions.
Recommendations	If available, provide recommendations for the project's M&E staff on effective data collection and monitoring of the program, lessons learned through the study, best tools and methodologies to be applied.

Annexes	Include the following as annexes, at minimum: • Terms of Reference. • Full description of Baseline Study methods. • All Baseline Study tools (e.g., questionnaires, checklists, discussion guides, surveys). • A list of sources of information (e.g., key informants, documents reviewed, other data sources). • Access to all primary data collected for the Baseline Study. • Performance indicator table with updated baseline data. Only if applicable, include as an annex Statement(s) of Differences regarding any significant unresolved differences of opinion on the part of funders, implementers, and/or members of the research team.
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The Consultant will be expected to provide ASA/WISHH with access to all primary data collected for the Baseline Study.

3.5 Research Team

The Consultant must have a team comprised of individuals with strong technical skills, experience in quantitative and qualitative research, study design, data collection and analysis, and technical competence in key project activities. In particular, the lead Consultants(s) will have the following qualifications:

- At least ten years of demonstrated experience conducting baseline studies and/or evaluations of agricultural development programs (required) and hold a graduate degree in agriculture, monitoring and evaluation, statistics, economics, or other related field (preferred).
- Experience conducting similar studies in Southeast Asia (required) and within Cambodia's aquaculture industry (preferred).
 - Consultants who do not have experience evaluating aquaculture programs in Cambodia are strongly encouraged to sub-contract with a technical expert(s) based in country to collect data for the Baseline Study.
- Experience conducting baseline studies for USDA, United States Agency for International Development (USAID), or other United States Government (USG) projects (required). Preference will be given to those who demonstrate experience with USDA and/or USAID indicators.
- Experience in quantitative data collection, statistics/econometrics such as quasi-experimental design, propensity score matching, regression, design effects, and questionnaire development.
- Experience designing tools for focus group discussions and key informant interviews and facilitating these sessions
- Demonstrable knowledge of participatory methods and commitment to best practices.
- Experience and capability in producing survey reports.
- Experience in study design and data collection and analysis of quantitative and qualitative data and supervisory capabilities of each of these areas.

- Fluent in written and spoken English; proficient in written and spoken Khmer (preferred).

The assessment will be independent and conducted by a third party. Specifically the regulations specify that the third party conducting the assessment:

- Is financially and legally separate from the participant's organization;
- Has staff with demonstrated knowledge, analytical capability, language skills and experience in conducting assessments of development programs involving agriculture, education, and nutrition;
- Uses acceptable analytical frameworks such as comparison with non-project areas, surveys, involvement of stakeholders in the assessment, and statistical analyses
- Uses local consultants, as appropriate, to conduct portions of the assessment; and,
- Provides a detailed outline of the evaluation, major tasks, and specific schedules prior to initiating the evaluation.

The Consultant is expected to:

- Develop a comprehensive study and data collection methodology (e.g., sample size and sampling methods).
- Conduct/coordinate and supervise quantitative and qualitative data collection.
- Communicate directly and frequently with ASA/WISHH staff (e.g., weekly updates, monthly progress reports) and invite stakeholders to participate in KIIs.
- Conduct data analysis and generate summary of findings.
- Draft the final report.

ASA/WISHH staff and implementing partners will be available to answer technical questions about program structure and implementation, and to provide guidance/advice on logistics, meeting arrangements, and other matters.

Attachment A: Proposal Guidelines and Selection Criteria

The candidate shall submit a full proposal to ASA/WISHH via an electronic submission to James Bernhardt at jbernhardt@soy.org (cc: arolo@soy.org) **no later than Monday, February 11th, 2019 at 5pm CST** with the following:

- Curriculum Vitae(s) of the lead consultant and assistants.
- References of similar work conducted by the applicant and recommendations if available.
- A technical proposal not to exceed 10 pages (not including annexes) that includes a clear description of the study's objectives and demonstrating a good understanding of the scope of work, the methodology, and a plan for data collection and analysis.
 - The methodology should include a detailed data collection plan, describing the data collection technique(s) to be used, related data collection sources, and a rationale for reasons the data collection was chosen.
- A line item budget including staff, travel, equipment, supplies, and professional

services, if applicable.

- A detailed work plan showing the resources needed, the time anticipated, and the outcomes/deliverables to be reached that includes a timeline of deliverables.

Proposals and associated documents must be submitted in English.

The following criteria will be used to review and score candidate proposals:

Table 3: Criteria for Scoring Proposals	
Criteria	Scoring (out of 100)
Soundness of proposed methodology	40 points
Skills and Past Experience	30 points
Past aquaculture experience in Cambodia	10 points
Quality control methods	10 points
Financial Competitiveness	10 points
Total:	100 points

Attachment B: Abbreviated Version of PMP with Standard Indicators

Table 4: Overview of Standard Indicators				
Indicator Number	Performance Indicator	Indicator Definition and Unit of Measurement	Data Source	Method/Approach of Data Collection or Calculation
1	<u>Standard #10:</u> Number of individuals who have received USDA-supported degree-granting non-nutrition-related food security trainings	<u>Definition:</u> This indicator measures the number of people who are currently enrolled in or have graduated during the reporting year from a degree-granting technical, vocational, associate, bachelor, master, or Ph.D. program. Disaggregate by sex (i.e., Male, Female) and duration (i.e., New, Continuing) <u>Unit of measurement:</u> Number of individuals	Course registration and completion records Attendance sheets and activity reports List of training topics covered under each activity (e.g., agronomy, plant pathology, anthropology)	Data to be captured electronically when possible Verification task to be performed at the end of each fiscal year Routine monitoring activities Baseline is zero
2	<u>Standard #12:</u> Number of organizations with increased performance with USDA assistance	<u>Definition:</u> This indicator measures whether USDA-funded capacity development efforts have led to improved organizational performance in organizations receiving organizational performance improvement support. Disaggregate by type of organization: • Research and educational • Private sector firms • Producer associations • Extension organizations • Government agencies • Non-governmental and not-for-profit organizations • Women's groups • Trade and business associations • Water users associations • Other <u>Unit of measurement:</u> Number of organizations	Adapted version of the Organizational Performance Index (OPI), balanced scorecard, or similar List of organizations receiving organizational performance improvement support Documented plans to assess outputs and outcomes and measure performance gaps	Data will be collected electronically from organizations that received training during Years 2, 3, and 4 of the project Verification task to be performed at the end of each fiscal year Routine monitoring activities Baseline is zero

3	Standard #9: Number of technologies, practices, and approaches under various phases of	Definition: This indicator tracks the progression of new or significantly improved technologies, practices, and approaches through research and development (R&D) to the	List of technologies, practices, and approaches Monthly or	Documentation of R&D strategies and phase of research Verification task to be performed at the end of
	research, development, and uptakes as a result of USDA assistance	demonstrated uptake by public or private sector stakeholders. Disaggregate by category of research: • Plant and Animal Improvement Research • Production Systems Research • Social Science Research Within each category disaggregate by phase of development: • Under research as a result of USDA assistance • Under field testing as a result of USDA assistance • Made available for uptake as a result of USDA assistance • Demonstrated uptake by the public and/or private sector with USDA assistance Unit of measurement: Number of technologies, practices, and approaches	quarterly progress reports Beneficiary records	each fiscal year Routine monitoring activities Baseline is zero
5	Standard #13: Number of public-private partnerships formed as a result of USDA assistance	Definition: The number of public-private partnerships in agriculture or nutrition formed during the reporting year due to USDA intervention (i.e., agricultural or nutrition activity, as described below). See USDA's indicator handbook for further information. Disaggregation by type of partnership (refer to the primary focus of the partnership if applicable): • Agricultural production • Agricultural post-harvest transformation • Nutrition • Multi-focus (use this if there are several components of the above sectors in the partnership) • Other (do not use this for multi-focus partnerships)	Beneficiaries to be provided with a mechanism to report any new private-public partnerships Clear agreement and/or documentation of cash or in-kind contribution	Self-reported by beneficiaries Verification task to be performed at the end of each quarter Data to be captured electronically when possible Baseline is zero

		<u>Unit of measurement:</u> Number of partnerships		
6	<u>Standard #21:</u> Number of individuals who have received short-term agricultural sector	<u>Definition:</u> The number of individuals to whom significant knowledge or skills have been imparted through interactions that are intentional, structured, and purposed for imparting	Attendance sheets or other to be completed for all trainings and capacity	Attendees to sign in before the training or other capacity building activity begins Data to be captured
	productivity or food security training as a result of USDA assistance	knowledge or skills should be counted as received training, through formal or informal means Disaggregations by gender (i.e., male/female) and new/continuing are required and disaggregation by type of individual to be included if applicable. See USDA's indicator handbook for further information. <u>Unit of measurement:</u> Number of individuals	building activities Check list of topics covered during these exercises to be completed by facilitators	electronically when possible Verification task to be performed at the end of each quarter Baseline is zero
7	<u>Standard #2:</u> Number of hectares under improved management practices or technologies that promote improved climate risk reduction and/or natural resources management with USDA assistance	<u>Definition:</u> This indicator measures the area in hectares where USDA-promoted management practices or improved technologies that reduce climate risk and improve land, marine, and other natural resources management were applied during the reporting year to areas managed or cultivated by producers participating in a USDA-funded activity. No disaggregation is required. <u>Unit of measurement:</u> Number of hectares	Beneficiary records and output for Standard #3 Monthly or quarterly site visits and/or phone calls	Baseline is the area under improved management practices and technologies that support improved climate risk reduction and/or natural resources management before October 2019 Routine monitoring activities
8	<u>Standard #3:</u> Number of hectares under improved management practices or technologies with USDA assistance	<u>Definition:</u> This indicator measures the area in hectares where USDA-promoted management practices or improved technologies were applied during the reporting year to areas managed or cultivated by producers participating in a USDA-funded activity. No disaggregation is required. <u>Unit of measurement:</u> Number of hectares	Beneficiary records and output for Standard #4 Monthly or quarterly site visits and/or phone calls	Baseline is the area under improved management practices and technologies before October 2019 Routine monitoring activities

10	Standard #4: Number of individuals in the agriculture system who have applied improved management practices or technologies with USDA assistance	Definition: This indicator measures the total number of agriculture system actors participating in USDA-funded activities who have applied improved management practices and/or technologies promoted by USDA anywhere within the food and agriculture system during the reporting year.	Beneficiary records and output for Standard #21 Monthly or quarterly site visits and/or phone calls Data	Baseline is the number of beneficiaries applying improved management or technologies at the start of the activity Site visits to speak with beneficiaries about improved management practices and technologies applied
		Disaggregate by value chain actor type (e.g., smallholder producers, people in government, other), sex (i.e., male, female), age (i.e., 15-29, 30+), management practice or technology type (e.g., crop genetics, cultural practices, livestock management), and commodity (i.e., type of crop, type of animal or animal product, or type of fish - freshwater or marine). Unit of measurement: Number of individuals	verification task to occur bi-annually	Data to be captured electronically when possible
11	Standard #22: Number of individuals participating in USDA food security programs	Definition: This is an output indicator measuring the number of individuals directly participating in USDA-funded interventions, including those we reach directly, those reached as part of a deliberate service strategy, and those participating in the markets we strengthen. See USDA's indicator handbook for further information. Disaggregate by sex (i.e., male/female), age category (i.e., 15-29, 30+), and type of individual (e.g., people in government, people in civil society, producers). Double-counting is not allowed for sex or age category but is allowed for type of individual. See USDA's indicator handbook for further information. Unit of measurement: Number of individuals	Program records such as attendance sheets ODK Collect and project database	Number of direct beneficiaries to be calculated following migration and cleaning of other activity specific data Cross tabulation of select activity level output indicators Baseline is zero

12	Standard #23: Number of individuals benefiting indirectly as a result of USDA assistance	Definition: This is an output indicator measuring the number of individuals indirectly benefitting from USDA-funded interventions. The individuals will not be directly engaged with a project activity or come into direct contact with a set of interventions (goods or services) provided by the project. See USDA's indicator handbook for further information. No disaggregation is required. Unit of measurement: Number of individuals	Activity specific records and output for Standard #22 ODK Collect and project database Monthly or quarterly site visits and/or phone calls	Self-reported by beneficiaries Number of indirect beneficiaries to be calculated following the verification of data described for Standard #22 Routine monitoring activities Baseline is zero
13	Standard #1: Yield of targeted agricultural commodities among program participants with USDA assistance	Definition: Yield is a measure of the total output of production of an agricultural commodity (crop, fish, milk, eggs, live animal offtake) divided by the total number of units in production (hectares planted of crops, area in hectares for pond aquaculture, cubic meters of cage for cage aquaculture, maximum number of animals in the herd/flock during the reporting year for live animals, maximum number of producing cows or hens during the reporting year for dairy or eggs). Yield per hectare, per animal and per cubic meter of cage is a measure of productivity from that farm, fisheries, or livestock activity from USDA-assisted producers. For aquaculture, disaggregate by commodity (i.e., type of fish - freshwater or marine), sex (i.e., Male, Female), and age (i.e., 15-29, 30+) Unit of measurement: • Total production (TP) for pond and cage aquaculture: kilograms (kg) • Total units of production (UP) for pond aquaculture: hectare of surface area • Total units of production (UP) for cage aquaculture: cubic meter of cage	Subset of target population to be surveyed during the baseline evaluation Records of sales shared by farms and firms Results of value chain assessment	Self-reported by beneficiaries Baseline data to reflect the yield of targeted commodities in the year prior to programming

14	Standard #18: Value of annual sales of farms and firms receiving USDA assistance	Definition: This indicator measures the value in U.S. dollars of the total amount of sales of products and services by USDA-assisted farms and firms during the reporting year within USDA-supported agricultural commodity value chains or markets. See USDA's indicator handbook for further information. Disaggregate by type of product or service (e.g., agricultural commodities, post-harvest storage and processing equipment, business services, production support services), type of	Beneficiaries who reported volume of commodities (metric tons) sold during the baseline evaluation Records of sales shared by farms and firms Results of value chain assessment	Self-reported by beneficiaries To utilize baseline data collected for Standard #19 Self-reported and to be verified in October of 2020, 2021, and 2022 Routine monitoring activities
		producer/firm (e.g., producer - smallholder, firm - microenterprise, firm - large enterprise or corporation), sex of producer or proprietor(s) (i.e., male, female, mixed), and age (i.e., 15-29, 30+, mixed). See USDA's indicator handbook for further information. Unit of measurement: U.S. Dollar	Beneficiary records and output for Standard #1	
15	Standard #19: Volume of commodities (metric tons) sold by farms and firms receiving USDA assistance	Definition: This indicator will collect the volume (as calculated in gross metric tons (MT)) of sales of targeted commodities by farms and firms receiving USDA assistance. This includes the volume of all sales of targeted commodity(ies), not just the volume of farm-gate sales. Disaggregate by commodity type (i.e., type of crop, type of animal or animal product, type of fish - freshwater or marine). The overall "horticulture" commodity disaggregate can be used if desired. Unit of measurement: Metric Tons	Subset of target population to be surveyed during the baseline evaluation Records of sales shared by farms and firms Results of value chain assessment Beneficiary records and output for Standard #18	Baseline survey to be administered during Year 1 of the project and to capture volume of agricultural commodities reported Routine monitoring activities

23	Standard #5: Number of individuals accessing agriculture-related financing as a result of USDA assistance	Definition: Total number of agricultural producers (individual farmers, fishers, cooperatives, etc.), input suppliers, transporters, processors, other Micro, Small and Medium enterprises (MSME), and larger enterprises that are in a targeted agricultural value chain and are participating in a USDA-funded activity that access agriculture-related financing with USDA assistance. This indicator counts individuals accessing debt (both cash and in-kind loans) and non-debt financing. Disaggregate by type of financing accessed (i.e., debt or non-debt). Debt should be further disaggregated by type of debt (i.e., cash, in-kind), size of recipient (e.g., individuals/microenterprises), sex of producer or proprietor(s) (i.e.,	Attendance records for finance trainings Checklist highlighting topics covered during finance trainings Documentation of new financing accessed by beneficiaries Monthly or quarterly site visits and/or phone calls	Attendees to sign in before structured finance trainings Self-reported financing activities Technical assistance provided during site visits to be documented Data to be captured electronically when possible Verification task to be performed at the end of each quarter Baseline is zero
		male, female, mixed), and age (i.e., 15-29, 30+, mixed). Non-debt should be further disaggregated by size of recipient (e.g., individuals/microenterprises), sex of producer or proprietor(s) (i.e., male, female, mixed), and age (i.e., 15-29, 30+, mixed). Unit of measurement: Number of individuals		
24	Standard #7: Number of loans disbursed as a result of USDA assistance	Definition: This indicator captures the number of loans made/dispensed during the reporting year as a result of USDA assistance to producers, input suppliers, transporters, processors, other MSMEs, and larger enterprises that are in a targeted agricultural value chain. No disaggregation is required. Unit of measurement: Number of loans	Beneficiary records documenting the number of loans received Monthly or quarterly site visits and/or phone calls	Self-reported by beneficiaries Routine monitoring activities Data to be captured electronically when possible Verification task to be performed at the end of each quarter Baseline is zero

25	<u>Standard #8:</u> Value of agriculture-related financing accessed as a result of USDA assistance	<u>Definition:</u> This indicator sums the total U.S. dollar value of debt (both cash and in-kind loans) and non-debt financing, such as equity financing, disbursed during the reporting year as a result of USDA- assistance to producers (individual farmers, fishers, cooperatives, etc.), input suppliers, transporters, processors, other MSMEs, and larger enterprises that are in a targeted agricultural value chain. The indicator counts the value of non-debt financing and both cash and non-cash lending disbursed to the participant, not financing merely committed (e.g., loans in process, but not yet available to the participant). See USDA's indicator handbook for further information. Disaggregate by type of financing accessed (i.e., debt or non-debt). Debt should be further disaggregated by type of debt (i.e., cash, in-kind), size of recipient (e.g.,	Beneficiary records documenting the amount of loans received Monthly or quarterly site visits and/or phone calls	Self-reported by beneficiaries Routine monitoring activities Data to be captured electronically when possible Verification task to be performed at the end of each quarter Baseline is zero
		individuals/microenterprises), sex of producer or proprietor(s) (i.e., male, female, mixed), and age (i.e., 15-29, 30+, mixed). Non-debt should be further disaggregated by size of recipient (e.g., individuals/microenterprises), sex of producer or proprietor(s) (i.e., male, female, mixed), and age (i.e., 15-29, 30+, mixed). <u>Unit of measurement:</u> U.S. Dollar		

27	Standard #17: Number of policies, regulations and/or administrative procedures in each of the following stages of development as a result of USDA assistance	Definition: Number of agricultural enabling environment policies/regulations/administrative procedures in the areas of agricultural resource, food, market standards & regulation, public investment, natural resource or water management, and climate change adaptation/mitigation as it relates to agriculture. See USDA's indicator handbook for further information. Disaggregation by stage (i.e., 1-5, other) is required. Unit of measurement: Number of policies, regulations, and/or administrative procedures and supplementary narrative(s)	Policies, regulations, and administrative procedures enacted to be captured in a questionnaire Quantitative and qualitative items to determine stage of progress	Document the implementation of a new policy, regulation, or administrative procedure Interview key informants with specialized knowledge about this topic Baseline is zero
29	Standard #14: Value of new USG commitments and new public and private sector investment leveraged by USDA to support food security and nutrition	Definition: Investment is defined as any use of public or private sector resources intended to increase future production output or income, to improve the sustainable use of agricultural-related natural resources (soil, water, etc.), or to improve water or land management anywhere along the food, feed and fiber system and natural resources management. Disaggregation by type of investment (i.e., host government, other public sector, private, new USG commitment) is required. Unit of measurement: U.S. Dollar	Beneficiary records Clear agreement and/or documentation of cash or in-kind contribution	Self-reported by beneficiaries Verification task to be performed at the end of each quarter Baseline is zero
30	Standard #11: Number of host government or	Definition: The indicator tracks the performance of activities working with national	Documentation of plans to identify risks	Routine monitoring activities

	community-derived risk management plans formally proposed, adopted, implemented or institutionalized with USDA assistance	governments, regional and/or local governments and/or communities to develop, implement, and institutionalize risk management plans. Disaggregate by type (i.e., Government, Community) and phase of development (i.e., Proposed, Adopted, Implemented, Institutionalized) <u>Unit of measurement:</u> Number of risk management plans	and their likelihood of occurrence Beneficiary records Checklist highlighting steps taken to develop, implement, and institutionalize risk management plans	Data to be captured electronically when possible Verification task to be performed at the end of each fiscal year Baseline is zero
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Attachment C: Abbreviated Version of IPTT with Custom Indicators

Table #5: Overview of Custom Indicators	
Indicator Number	Performance Indicator
4	<u>Custom #1</u> : Number of private enterprises, producers organizations, water user associations, women's groups, trade and business associations, and community-based organizations (CBOs) who received short-term agricultural sector productivity, food security or other training as a result of USDA assistance
9	<u>Custom #2</u> : Area of ponds (cubic meters) under improved management practices or techniques with USDA assistance
16	<u>Custom #3</u> : Number of hatcheries or feed mills providing seed or feed that meets international quality standards
17	<u>Custom #4</u> : Number of beneficiaries who subscribe to receive market information about price and availability of aquaculture products
18	<u>Custom #5</u> : Number of market actors selling fish who are compliant with national SPS standards or are using an independent quality seal
19	<u>Custom #6</u> : Number of farms that increased the number, size, or amount of ponds, cages, or equipment with USDA assistance
20	<u>Custom #7</u> : Number of value chain actors with increased capacity and utilization of cold chain assets
21	<u>Custom #8</u> : Number of production contracts created between wholesalers and aquaculture producers
22	<u>Custom #9</u> : Number of individuals who visited the CE SAIN research technology parks in Battambang and Kampong Thom
26	<u>Custom #10</u> : Number of wholesalers who report an increase in volume or improvement in quality of specific fish varieties available in the aquaculture value chain
28	<u>Custom #11</u> : Number of business plans developed that include marketing and distribution strategies

Attachment D: Project-Level Results Framework(s)

Figure 1: USDA Results Framework with CAST Activities (SO1)

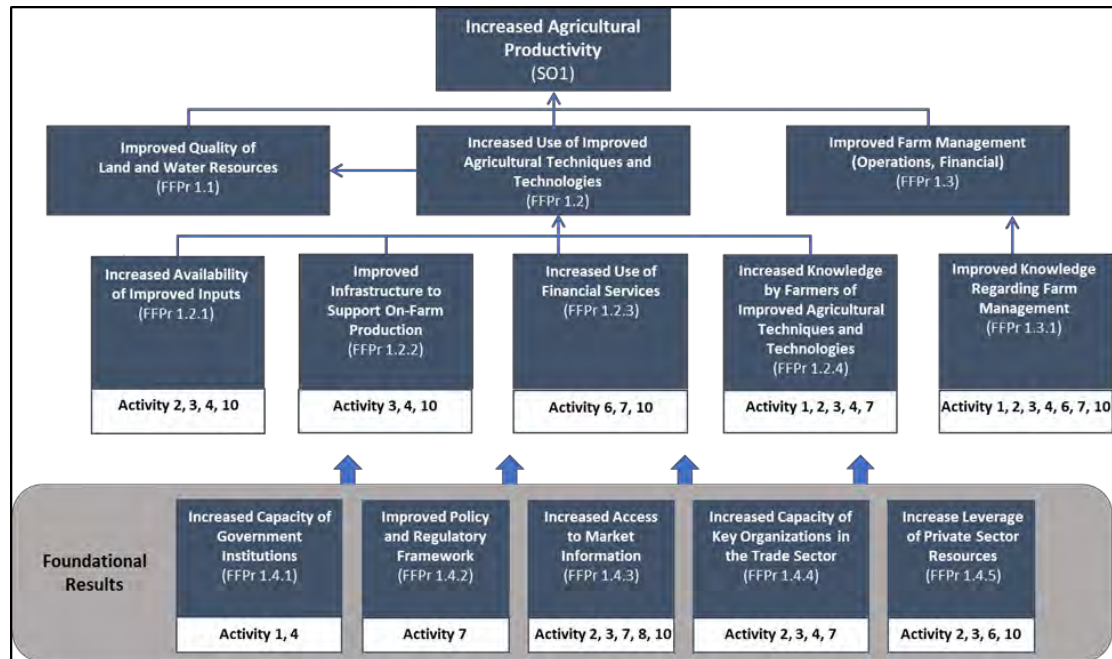
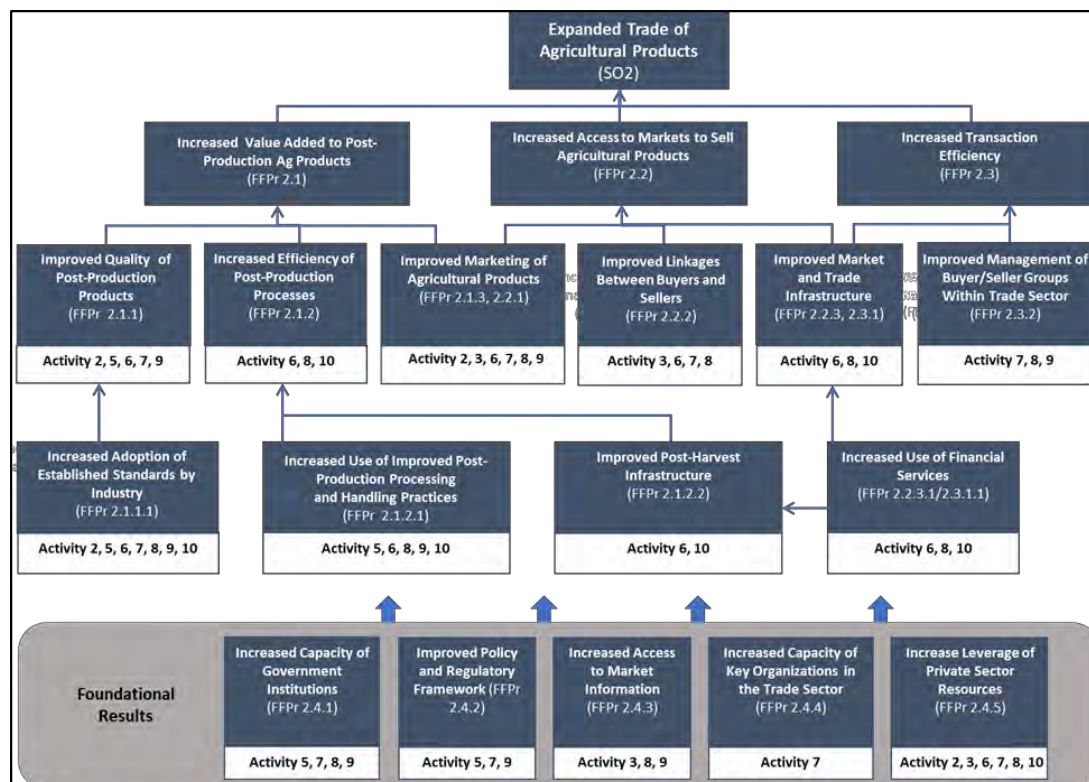


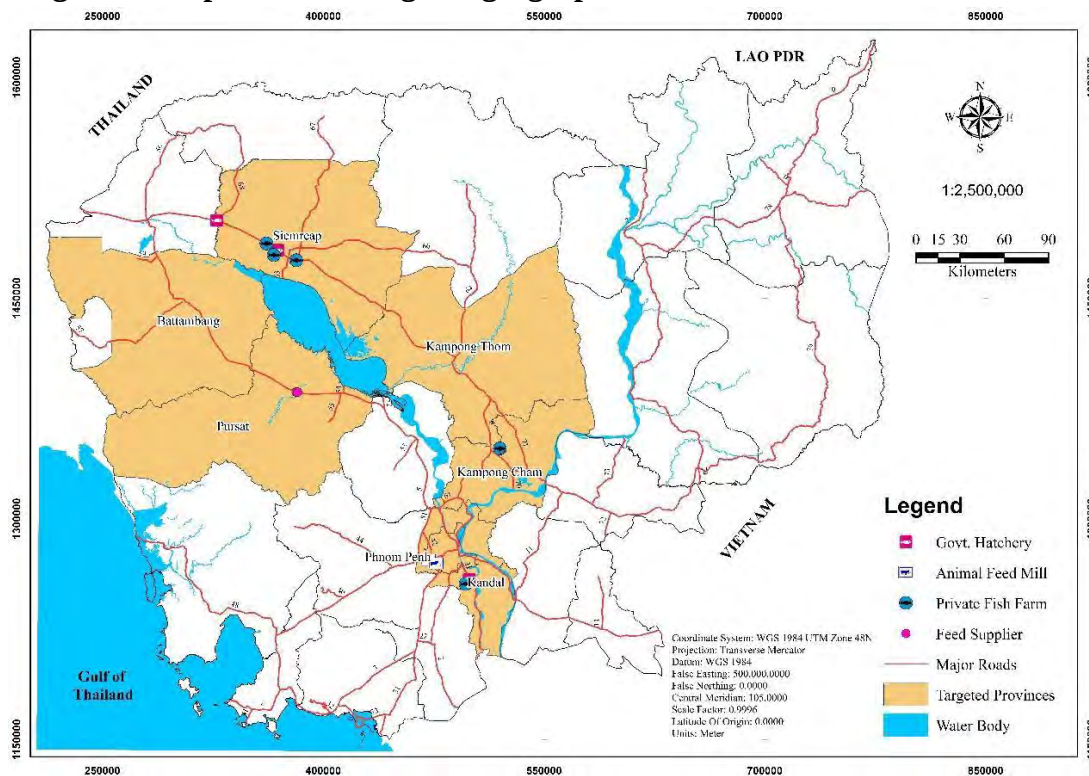
Figure 2: USDA results framework with CAST activities (SO2)



Attachment E: Project Implementation Map

The map below shows the geographic area in Cambodia to be covered by the program. The program will be focusing on specific geographic areas. The provinces targeted by the program include: Siem Reap, Battambang, Pursat, Kampong Thom, Kampong Cham, Kandal, and Phnom Penh.

Figure 3: Map of CAST-targeted geographies



ANNEX B: SAMPLING FRAMEWORK

Sampling Methodology

The sampling methodology comprises three main stages:

- 1) sampling proposal;
- 2) sampling finalization;
- 3) sample selection.

As a result, a target sample size of 1,422 respondents in nine categories – aquaculture farmer, feed mill, hatchery, nursery, aquaculture fish processor, wholesaler, financial institution, collector, and feed distributor – was determined (Table A). A random selection method is used to select respondents in the aquaculture farmer category, whereas a purposive selection is employed to select respondents in the other eight categories. Details of the sampling methodology are subsequently discussed as follows.

Table A: Summary of target sample size by category and location

Nº	Location	Aquaculture farmer			Other value chain actors									All (I + II)
		Treatment	Control	Total (I)	Feed mills	Hatcheries	Nurseries	Processors	Wholesalers	Collectors	Feed distributors	Financial institutions	Total (II)	
1	Battambang	97	0	97	0	9	2	4	3	3	3	3	27	124
2	Kampong Cham	138	0	138	1	0	1	2	3	3	3	3	16	154
3	Kampong Thom	95	0	95	0	3	1	7	3	5	3	3	25	120
4	Kandal	77	0	77	1	3	2	2	2	6	3	3	22	99
5	Pursat	260	0	260	0	5	0	3	3	5	3	3	22	282
6	Siem Reap	152	0	152	0	6	1	5	3	3	3	3	24	176
7	Phnom Penh	75	0	75	8	0	3	2	4	5	3	3	28	103
8	Banteay Meanchey	0	34	34	0	0	0	2	2	4	3	3	14	48
9	Kampong Chhnang	0	126	126	0	2	0	4	4	6	3	3	22	148
10	Takeo	0	140	140	0	12	0	2	3	5	3	3	28	168
	Total	894	300	1,194	10	40	10	33	30	45	30	30	228	1,422

Sampling proposal

To allow for an impact evaluation of the project, both treatment and control groups have been proposed. Sample sizes of these two groups and their locations at provincial level have been proposed and discussed at the pre-inception phase of this study, i.e. during the proposal bidding stage. There are seven locations for the treatment group, including Phnom Penh, Kandal, Kampong Cham, Pursat, Battambang, Kampong Thom, and Siem Reap; and three locations for the control group, comprising Takeo, Kampong Chhnang and Banteay Meanchey. Kampong Chhnang has been selected to capture aquaculture production using cage technology, whereas Takeo and Banteay Meanchey are to represent pond technology.

Based on the sample size calculating formula⁵⁶, with a margin of error of 3% and a confidence interval of 95%, the population of aquaculture farmers that the study team received at that time was used to determine the target sample size for aquaculture farmers.

For the treatment group, the sample size of 894 aquaculture farmers was determined, given a population of 5,500 aquaculture farmers. For the control group, the sample size was determined at 260 aquaculture farmers (Table B).

Table B: List of population of aquaculture farmers by provinces

Nº	Location	Proposed Sample (Initial)
Treatment group		894
1.	Battambang	54
2.	Kampong Cham	138
3.	Kampong Thom	124
4.	Kandal	243
5.	Pursat	51
6.	Siem Reap	71
7.	Phnom Penh	213
Control group		260
8.	Banteay Meanchey	122
9.	Kampong Chhnang	103
10.	Takeo	35
Total		1,154

For other value chain actors of the aquaculture sector, which are composed of eight categories, several assumptions were made to determine their sample sizes, as explained in Table C. These assumptions were mainly based on the experience of experts in the study team, particularly the World Fish team, who have extensive knowledge of the aquaculture sector in Cambodia. The number of respondents for these eight categories has been proposed to be 228 people.

⁵⁶ Formula calculating sample size:

$$n = \frac{\frac{z^2 r(1-r)}{e^2}}{1 + \frac{z^2 r(1-r)}{e^2 N}}$$

Where, n = Sample size; z = z-score (following the normal distribution); N = Population size; r = Response distribution, assumed at 50%.

Table C: List of proposed target sample in other sample categories (purposive selection)

Sample group	Number of respondents		Total	Notes
	Treatment	Control		
1. Feed mill	(Not applicable)		10	1 aquaculture feed mill, 9 animal feed mills
2. Hatchery	26	14	40	Hatcheries producing at least 100,000 fingerlings per year
3. Nursery	(Not applicable)		10	▪ Nursing (short period) or trading fish fingerlings. Most of them are importing fingerlings from Vietnam ▪ Treatment and control will be assigned after validation of “active” nurseries
4. Aquaculture fish processor	25	8	33	▪ Fish processor sourcing at least 20% of their raw material from Cambodian aquaculture farms. Some can have a wholesaler’s activities but will be considered as Fish processors for the survey.
5. Wholesaler	21	9	30	▪ Buying and selling fish and sourcing at least 20% of their material from aquaculture farms in Cambodia. They can purchase directly at the farm or from collectors. Their trade volume per transaction is larger than that of Collectors and transportation is by truck or car. ▪ Top three per province in volume, with a selection criteria: 20 % of their trade volume are sourced from aquaculture
6. Financial institution	21	9	30	3 per province
7. Collector	30	15	45	▪ Buying and selling fish directly at the farm. Re-selling directly to retailers, wholesalers or processors. Their trade volume per transaction is limited (<1 ton) and transportation is by motorbike and rarely by car. ▪ 5 collectors operating in the clusters of producer surveyed. No collector in Phnom Penh, due to proximity to markets
8. Feed distributor	21	9	30	3 per province
Total Sample	148*	63*	228	

Note: *Excluding feed mill and nursery categories.

Sampling finalization

A listing process was implemented to collect information of respondents in the nine categories proposed above. As a result, 1,209 potential respondents in the aquaculture farmer category and 406 respondents in the other categories, except for financial institutions, have been listed as summarized in Table D. The aquaculture farmers have been selected for the following criteria: pond area above 200m² or cage volume above 30m³ and marketing more than 80% of their production. Two criteria were additionally applied in the listing to capture more commercial-scale aquaculture farmers with pond size of 300m² or above, and with cage volume of 40m³ or above. Those farmers are considered as more “commercial” and to be a priority target for the project, and were included in the sampling framework.

Table D: Listing resulting by location and sample category

N°	Location	Aquaculture Farmer	Feed mill	Hatchery	Nursery	Processor	Wholesaler	Collector	Feed distributor	All
1	Battambang	130	0	9	5	10	5	5	11	175
2	Kampong Cham	188	1	0	2	5	8	4	7	215
3	Kampong Thom	129	0	3	1	17	4	8	10	172
4	Kandal	118	1	3	2	4	2	9	4	143
5	Pursat	337	0	5	0	8	8	7	10	375
6	Siem Reap	205	0	6	2	12	21	4	10	260
7	Phnom Penh	102	8	0	4	5	17	8	4	148
8	Banteay Meanchey	46	0	0	0	5	4	6	4	65
9	Kampong Chhnang	535	0	2	0	17	27	10	5	596
10	Takeo	218	0	12	0	9	8	9	9	265
	Total	2,008	10	40	16	92	104	70	74	2,414

Source: Listing activity performed by World Fish team in March-April 2019.

Aquaculture farmer, treatment group. Using the listing results, the proposed sample size at the provincial level has been adjusted accordingly, especially for the aquaculture farmer category (Table E). At this stage, a non-response rate of 30%⁵⁷ has been taken into the calculation process. This means that achieving a sample target of 894 respondents in the treatment group would require reaching 1,277 potential respondents in the survey. Since this number exceeds the listed number of 1,209, all the listed respondents will be approached for interviews. These respondents are distributed into 200 villages of 117 communes in 39 districts of seven provinces.

⁵⁷ This is based on experience of previous survey projects that Nuppun team has implemented.

Table E: Aquaculture farmer sample distribution (treatment group, provincial level)

Province	Potential			Target	
	Commercial (>300m2) (>40m3)	Other	Total	Sample	% total
Battambang	16	114	130	97	11%
Kampong Cham	7	181	188	138	15%
Kampong Thom	53	76	129	95	11%
Kandal	49	69	118	77	9%
Pursat	44	293	337	260	29%
Siem Reap	27	178	205	152	17%
Phnom Penh	102	0	102	75	8%
Total treatment sample	298	911	1,209	894	100%

Aquaculture farmer, control group. The initial sample size has been revised upward to 300 from the initial target of 260 respondents, to better capture different technologies used in aquaculture between pond and cage (Table F). Around 60% of aquaculture production was from pond techniques and the remaining 40% from cage.⁵⁸ To achieve the target of 300 respondents would require approaching 408 potential respondents. Given that the number of listed aquaculture farmers was 799 people, well exceeding the number of potential respondents, a random selection could be applied in this case. Since there were only 46 aquaculture farmers listed in Banteay Meanchey province, which uses mainly pond technology, the potential sample size in the other two provinces had to be adjusted to reflect the ratio of pond and cage techniques. As a result, the potential sample size in Kampong Chhnang and Takeo provinces has been set at 171 respondents and 191 respondents respectively (Table F).

Table F: Aquaculture farmer sample distribution (control group, provincial level)

Province	Potential			Target	
	Commercial (>300m2) (>40m3)	Other	Total	Sample	% total
Banteay Meanchey	0	46	46	34	11%
Kampong Chhnang	10	161	171	126	42%
Takeo	14	177	191	140	47%
Total control sample	24	384	408	300	100%

⁵⁸ National Strategic Plan for Aquaculture Development in Cambodia (2016-2030).

Additional Tables

Table G: Aquaculture farmer sample distribution (treatment group, district level)

Province/District	Potential	Target
Battambang	130	97
Aek Phnum	55	41
Bavel	7	5
Moung Ruessei	13	10
Sangkae	23	17
Thma Koul	32	24
Kampong Cham	188	138
Batheay	52	38
Cheung Prey	45	33
Kampong Siem	48	35
Kang Meas	31	23
Prey Chhor	12	9
Kampong Thom	129	95
Baray	6	4
Kampong Svay	8	6
Santuk	6	4
Stoung	13	10
Stueng Sen	29	21
Stuong	67	50
Kandal	104	77
Kaoh Thum	4	3
Kien Svay	16	12
Leuk Daek	25	18
Mukh Kampul	23	17
Popnhea Lueu	36	27
Pursat	351	260
S'ang	14	10
Bakan	156	115
Kandieng	44	33
Krakor	116	86
Krong Pursat	21	16
Siem Reap	205	152
Chi Kraeng	30	22
Kra Lanh	21	16
Krong Siem Reap	28	21
Pork	6	4
Prasat Bakong	2	2
Puk	29	21
Soutr Nikom	89	66
Phnom Penh	102	75
chbar Ampov	6	4
Chroy Chnagva	3	2
Mean Chey	5	4
Prek Phnov	65	48
Reu Sey Kao	22	16
Sen Sok	1	1
Total treatment sample	1,209	894

Table H: Aquaculture farmer sample distribution (control group, district level)

District	Potential	Target
Banteay Meanchey	46	34
Krong Serei Saophoan	8	6
Malai	3	2
Mongkol Borei	17	13
Ou Chrov	11	8
Preah Netr Preah	2	1
Thma Puok	5	4
Kampong Chhnang	171	126
Baribour	44	32
Chol Kiri	15	11
Kampong Leaeng	28	21
Kampong Tralach	50	37
Krong Kampong Chhnang	17	13
Rolea B'ier	6	4
Sameakki Mean Chey	6	4
Tuek Phos	5	4
Takeo	191	140
Angkor Borei	9	7
Bati	46	33
Kiri Vong	9	7
Koh Andet	7	5
Krong Doun Kaev	4	3
Samraong	36	26
Tram Kak	79	58
Tram Kak	1	1
Total	408	300

Table 1: Aquaculture farmer sample distribution (treatment group, commune level, potential)

District/Commune	Battambang	Kampong Cham	Kampong Thom	Kandal	Pursat	Siem Reap	Phnom Penh	Total
Aek Phnum	55							55
Kaoh Chiveang	21							21
Peam Aek	6							6
Prey Chas	28							28
Bavel	7							7
Bavel	2							2
Khnach Romeas	2							2
Prey Khpos	3							3
Moung Ruessei	13							13
Chrey	2							2
Kear	3							3
Robas Mongkol	7							7
Ta Loas	1							1
Sangkae	23							23
Kampong Pring	16							16
Norea	6							6
Ou Dambang Muoy	1							1
Thma Koul	32							32
Anlong Run	8							8
Bansay Traeng	9							9
Chrouy Sdau	1							1
Ou Ta Ki	1							1
Ta Meun	13							13
Batheay		52						52
Chbar Ampov		11						11
Chea Lea		6						6
Tang Krang		35						35
Cheung Prey		45						45
Prey Char		6						6
Sdaeung Chey		4						4
Soutip		35						35
Kampong Siem		48						48
Kien Chrey		48						48
Kang Meas		31						31
Preaek Koy		11						11
Preaek Krabau		11						11
Sdau		9						9
Prey Chhor		12						12
Boeng Nay		3						3
Chrey Vien		5						5
Prey Chhor		4						4

Baray			6				6
Baray			2				2
Sraloa			2				2
Treal			2				2
Kampong Svay			8				8
Kampong Kour			1				1
Pat Sanday			5				5
San Kor			2				2
Santuk			6				6
Tboung Kravpeur			6				6
Stoung			13				13
Kampong Chin Tboung			13				13
Stueng Sen			29				29
Achar Leak			2				2
Damrei Choan Khla			2				2
Kampong Krabau			20				20
Prey Ta Hu			1				1
Srayov			4				4
Stuong			67				67
Msar Krong			13				13
Peam Bang			54				54
Kaoh Thum				4			4
Chheu Khmau				1			1
Chrouy Ta Kaev				2			2
Chrouy Takeo				1			1
Kien Svay				16			16
Kokir				3			3
Kokir Thum				11			11
Samraong Thum				2			2
Leuk Daek				25			25
Kampong Phnum				1			1
Khpob ateav				4			4
Peam Reang				2			2
Preaek Dach				8			8
Preaek Tonloab				10			10
Mukh Kampul				23			23
Preaek Dambang				4			4
Roka Kaong Muoy				1			1
Sambuor Meas				13			13
Svay Ampear				5			5
Popnhea Lueu				36			36
Chrey Loas				1			1
Kampong Loung				23			23

Kampong Luong				1				1
Kaoh Chen				2				2
Ponhea Lueu				1				1
Preaek Ta Teaen				7				7
Vihear Luong				1				1
S'ang				14				14
Kraing Yov				1				1
Krang Yov				8				8
Prasat				2				2
Roka Khpos				1				1
Svay Prateal				1				1
Talon				1				1
Bakan					156			156
Me Tuek					141			141
Rumlech					9			9
Snam Preah					6			6
Kandieng					44			44
Reang Til					44			44
Krakor					116			116
Anlong Tnaot					11			11
Kampong Luong					70			70
Kbal Trach					15			15
Sna Ansa					20			20
Krong Pursat					21			21
Roleab					21			21
Chi Kraeng						30		30
Anlong Samnor						29		29
Resey Lork						1		1
Kra Lanh						21		21
Kra Lanh						10		10
Sra Nal						11		11
Krong Siem Reap						28		28
Chhreav						2		2
Chong Kneas						3		3
Sala Kamreuk						1		1
Savy Dangkoum						4		4
Siem Reap						15		15
Slor Kroum						2		2
Sombuor						1		1
Pork						6		6
Prey Chhrouk						6		6
Prasat Bakong						2		2
Bar Lang						1		1
Mean Chhey						1		1
Puk						29		29

Koa Por						29		29
Soutr Nikom						89		89
Dan Run						8		8
Dom Dek						2		2
Kampong Kleang						74		74
Khchass						5		5
Chbar Ampov							6	6
Prek Eng							2	2
Prek Pra							4	4
Chroy Chnagva							3	3
Chroy Chnagva							1	1
Prek Takong							2	2
Mean Chey							5	5
Chak Angre Krom							5	5
Prek Phnov							65	65
Kok Rokar							1	1
Ponhea Porn							4	4
Prek Phnov							37	37
Samrong							22	22
Sarong							1	1
Reu Sey Kao							22	22
Chrang Chamres 1							11	11
Chrang Chamres 2							2	2
Kilomet 6							3	3
KM 6							1	1
Svay Pak							5	5
Sen Sok							1	1
Khmournh							1	1
Total	130	188	129	118	337	205	102	1,209

Table J: Aquaculture farmer sample distribution (control group, commune level, potential)

District/Commune	Banteay Meanchey	Kampong Chhnang	Takeo	Total
Krong Serei Saophoan	8			8
Phniet	6			6
Tuek Thla	2			2
Malai	3			3
Tuol Pongro	3			3
Mongkol Borei	17			17
Banteay Neang	3			3
Chamnaom	2			2
Koy Maeng	6			6
Paoy Char	2			2
Rohat Tuek	2			2
Ta Lam	2			2
Ou Chrov	11			11
Koub	1			1
Kuttasat	6			6
Samraong	4			4
Preah Netr Preah	2			2
Preah Netr Preah	1			1
Tuek Chour	1			1
Thma Puok	5			5
Kumru	1			1
Phum Thmei	4			4
Baribour		44		44
Chhnok Tru		37		37
Khon Rang		6		6
Trapeang Chan		1		1
Chol Kiri		15		15
Peam Chhkaok		15		15
Kampong Leaeng		28		28
Phlov Tuk		10		10
Pralay Meas		4		4
Samraong Saen		12		12
Svay Rumpea		2		2
Kampong Tralach		50		50
Ampil Tuek		14		14
Kampong Tralach		21		21
Saeb		9		9
Ta Ches		6		6
Krong Kampong Chhnang		17		17
Phsar Chhnang		17		17
Rolea B'ier		6		6
Rolea B'ier		5		5
Svay Chrum		1		1

Sameakki Mean Chey		6		6
Sedthei		6		6
Tuek Phos		5		5
Akphivoadth		2		2
Tang Krasang		2		2
Khlong Popok		1		1
Angkor Borei			9	9
Angkor Borei			2	2
Ba Srae			3	3
Prey Phkoam			3	3
Ponley			1	1
Bati			46	46
Chambak			1	1
Komar Reachea			11	11
Krang Leav			29	29
Trapeang Krasang			5	5
Kiri Vong			9	9
Angk Prasat			2	2
Preah Bat Choan Chum			6	6
Soum			1	1
Koh Andet			7	7
Rominh Choeurng			7	7
Krong Doun Kaev			4	4
Roka Knong			4	4
Samraong			36	36
Boeng Tranh Khang Tboung			4	4
Chumreah Pen			17	17
Khvav			5	5
Rovieng			7	7
Samraong			2	2
Soeng			1	1
Tram Kak			79	79
Angk Ta Saom			5	5
Cheang Tong			9	9
Kus			3	3
Leay Bour			2	2
Nhaeng Nhang			1	1
Otdam Souriya			3	3
Ou Saray			11	11
Popel			4	4
Ta Phem			6	6
Trapeang Kranhung			13	13
Trapeang Thum Khang Cheung			14	14
Trapeang Thum Khang Tboung			8	8
Samrong			1	1

Lum Chang			1	1
Total	46	171	191	408

Sampling framework after survey completion

*Table K: Treatment provinces (Note: * new selected district)*

Province	District	Potential	Target	Realized
Battambang		130	97	96
	Aek Phnum	55	41	48
	Bavel	7	5	4
	Moung Ruessei	13	10	7
	Sangkae	23	17	25
	Thma Koul	32	24	8
	Battambang*			1
	Rukhak Kiri*			3
Kampong Cham		188	138	137
	Batheay	52	38	54
	Cheung Prey	45	33	25
	Kampong Siem	48	35	35
	Kang Meas	31	23	17
	Prey Chhor	12	9	6
Kampong Thom		129	95	109
	Baray	6	4	3
	Kampong Svay	8	6	13
	Santuk	6	4	3
	Stueng Sen	29	21	16
	Stuong	80	60	73
Kandal		118	87	99
	Kaoh Thum	4	3	3
	Kien Svay	16	12	19
	Leuk Daek	25	18	16
	Mukh Kampul	23	17	19
	Popnhea Lueu	36	27	22
	S'ang	14	10	20
Pursat		337	250	245
	Bakan	156	115	115
	Kandieng	44	33	39
	Krakor	116	86	73
	Krong Pursat	21	16	18
Siem Reap		205	152	162
	Chi Kraeng	30	22	24
	Kra Lanh	21	16	14
	Krong Siem Reap	28	21	19
	Prasat Bakong	2	2	3
	Puk	35	25	27

	Soutr Nikom	89	66	75
Phnom Penh		102	75	70
	chbar Ampov	6	4	6
	Chroy Chnagva	3	2	1
	Mean Chey	5	4	2
	Prek Phnov	65	48	47
	Reu Sey Kao	22	16	14
	Sen Sok	1	1	0
TOTAL TREATMENT		1209	894	918

Table L: Control provinces

Province	District	Potential	Target	Realized
Banteay Meanchey		46	34	34
	Krong Serei Saophoan	8	6	0
	Malai	3	2	0
	Mongkol Borei	17	13	18
	Ou Chrov	11	8	11
	Preah Netr Preah	2	1	0
	Thma Puok	5	4	5
Kampong Chhnang		171	126	146
	Baribour	44	32	45
	Chol Kiri	15	11	13
	Kampong Leaeng	28	21	20
	Kampong Tralach	50	37	46
	Krong Kampong Chhnang	17	13	15
	Rolea B'ier	6	4	4
	Sameakki Mean Chey	6	4	0
	Tuek Phos	5	4	3
Takeo		191	140	106
	Angkor Borei	9	7	09
	Bati	46	33	11
	Bourei Cholsar			1
	Kiri Vong	9	7	16
	Koh Andet	7	5	13
	Krong Doun Kaev	4	3	2
	Prey Kabas			3
	Samraong	36	26	14
	Tram Kak	80	59	25
	Treang			12
TOTAL CONTROL		408	300	286

Table M: Percentage of farm replaced in the sample compared to planned sampling

Type	Farm identified during scoping and interviewed	% Farm identified during scoping and interviewed	Newly selected farms	% of Newly selected farms	Total
Treatment	392	46%	459	54%	851
Control	86	30%	203	70%	289
Total	478	42%	662	58%	1,140

Replacement of farmer identified during the scoping exercise happen because of:

- Listing was not accurate- famer name or location was incorrect
- Farmer listed already stopped fish farming activities
- Farmers listed did not responded to the selection criteria and were excluded
- Identified farmer refused to join the survey

Farmer were replaced by other farmers within the same commune or district.

Table N: Change made in the survey methodology during implementation

Content area	Original plan	Change made	Rationale
Sampling approach and strategy	Random selection of respondents based on data collecting during scoping exercise	No longer random, but purposive. Adjustment of rules due to: - logistic issues by substituting and replacing farmers in remote area by farmers located near other sampled farmers - low accuracy of listing of aquaculture producers. Replacement by other farmers in the same commune	The analysis will be influenced by the proportion of replacement versus the original plan. If exceeding 15%, then it will not be a randomized sample but a purposive selection. However, the sample was exhaustive in the different district visited and correspond to more than 95% of the existing aquaculture producers in district where aquaculture is happening. We therefore consider this approach being close of a census and representative of the entire aquaculture population.
Data collection for purposive sample	A select number of respondents to be interviewed in person by Nuppun Research & Consulting	10 MFI and one feed mill, interviews were conducted over the phone.	To ensure accuracy of administrative data as respondent need to check his/her record to answer the question(s). Limit transport cost and time to provinces
	Key Informant Interview selected within the Purposive sample	Select another respondent for KII or purposive sample selection due to survey fatigue (3 cases)	Survey fatigue of respondent having to respond to two survey within 1 month increased non-response rate
Approach to MFI	Approaching MFI directly at provincial level	Approaching MFI at Headquarter in Phnom to get access to information in province	MFI office in province were reluctant to respond to our survey

Table O: Planned and Realized Purposive Sample

Location	Plan	Realize	Plan	Realize	Plan	Realize	Plan	Realize	Plan	Realize	Plan	Realize	Plan	Realize	Plan	Realize
	Feed mill	Feed mill	Hatchery	Hatchery	Nursery	Nursery	Processor	Processor	Wholesaler	Wholesaler	Collector	Collector	Feed distributor	Feed distributor	Financial institution	Financial institution
Phnom Penh	8	6	0	0	3	1	2	3	4	4	5	3	3	1	3	1
Kandal	1	1	3	2	2	1	2	2	2	2	6	3	3	0	3	1
Kampong Cham	1	1	0	3	1	2	2	2	3	4	3	1	3	2	3	1
Kampong Thom	0	0	3	1	1	1	7	8	3	3	5	5	3	3	3	1
Siem Reap	0	0	6	3	1	1	5	5	3	3	3	3	3	3	3	3
Battambang	0	0	9	5	2	2	4	4	3	2	3	4	3	5	3	2
Pursat	0	0	5	3	0	0	3	2	3	3	5	5	3	3	3	2
Takeo	0	0	12	12	0	1	2	2	3	3	5	5	3	3	3	3
Kampong Chhnang	0	0	2	1	0	0	4	4	4	4	6	6	3	3	3	2
Banteay Meanchey	0	0	0	0	0	0	2	2	2	1	4	5	3	1	3	1
Total	10	8	40	30	10	9	33	34	30	29	45	40	30	24	30	17

ANNEX C: QUESTIONNAIRES & SURVEY TOOLS

Introductory statement

This survey is being conducted by Nuppun Research & Consulting together with WorldFish to assess the current status of the aquaculture sector in Cambodia. The results of this survey will help to design a USDA-funded project called Commercialization of Aquaculture for Sustainable Trade (CAST) Cambodia which will support the development of aquaculture in Cambodia for the next four years. The project intends to develop the commercial aquaculture industry by linking different actors within the value chain while also improving the technical and managerial practices of numerous value chain actors.

We will use data collected in this survey to assess how producers, hatcheries, fish buyers, wholesalers, processors, aquaculture feed producers and retailers are operating, and to identify the main constraints, if any, that are limiting their performance.

Participation in this survey is completely voluntary, and you may choose not to take part in this survey. If you decide to take part in this survey, you may stop participating at any time. If you decide not to take part in this survey, or if you stop participating at any time, you will not be penalized or lose any program benefits for which you would otherwise qualify.

We encourage you to answer questions honestly and hope that you will answer all of our questions. However, you may skip any questions that you do not wish to answer. I will read each question aloud to you. Please let me know if the meaning of a question is not clear so that I can provide you with additional guidance.

The questionnaire will take about 90 minutes to complete. We will ask you questions about the infrastructure and equipment on your farm or within your business, and about the production and trade of fish from your property. We will also ask you questions about the techniques you use and about the farm management practices that you follow. The survey also includes questions about your ability to obtain financing for your farm or business, and about how you access additional information about fish production, processing and trade.

Do you have any questions? If not, are you willing to participate in the survey?

MODULE A. BENEFICIARY REGISTRATION

NOTE: I am now going to ask you a number of questions about the persons working on your farm or for your company.

Interviewer Name: _____ Date : _____ Start time : _____ End time: _____

1: Interview ID:_(Beneficiaries Type code-1Digit + ID- 4 Digits)

2. Name of the respondent: _____

3. Age of respondent: _____

4. Gender of respondent (1 = Male/2 = Female): ☐ ☐

5. Name of the manager/ head of household if different than Q2: _____

8. Age of manager/ head of household if different than Q2 _____

9. Gender of manager/ head of household (1 = Male/2 = Female): ☐ ☐

10. Telephone contact of manager/ head of household: _____

11. Alternative contact of manager/ head of household: _____

12. Province: _____ (1 = Phnom Penh; 2 = Kandal; 3 =Kampong Cham; 4 = Kampong Thom; 5= Siem Reap; 6 =Battambang; 7= Pursat; 8= Takeo; 9 = Kampong Chhnang; 10= Beantay Meanchey)

13. District: _____(drop down list)

14. Commune: _____(drop down list)

15. Village: _____(drop down list)

16. GPS _____

17: What is the primary activity of the Beneficiary: 1: HATCHERY; 2: NURSERY; 3: FISH PRODUCER; 4: COLLECTOR; 5: WHOLESALER; 6: PROCESSOR; 7 FEED MILL; 8: Micro-finance and finance institution; 9: FEED DISTRIBUTOR: _____

18 .When did you/your firm start your/its main activity (YYYY): _____

If Q17 is 1 or 2, >>Q19; If NO>>MODULE B

Q19: Are you a government hatchery (1=YES 2= NO): ☐

Q19.1: Besides producing fingerlings, do you also produce farmed fish for selling (1= YES; 2 =NO): ☐

If Q17 is 5 or 6, >>Q20; If NO>>MODULE B

Q20: In 2018, were you and your business involved in: 1= FISH WHOLESALE ONLY; 2= FISH PROCESSING ONLY; 3= BOTH WHOLESALE AND PROCESSING: ☐

If Q17 is 7 or 8 or 9, >>Q21; If NO>>MODULE B

21. Name of company _____

22. Position of respondent in company: ☐

- ☐ 1. Chair/Director/Owner
- ☐ 2. Vice-Chair/Vice-Director
- ☐ 3. Employee
- ☐ 4. Treasurer
- ☐ 5. Secretary
- ☐ 6. Head of department
- ☐ 99. Other (specify) _____

MODULE B: COMPANY HUMAN RESOURCES

IF Q17 is 1,2,3,4,5,6,9 then >>Q23

If Q17 is 7 or 8 >> Ask only Q27

NOTE: I am now going to ask you a number of questions about the persons living in your household and working at your farm. Please note that we are interested in the current situation, not past experiences or future plans.

B1. HOUSEHOLD LABOR

		23	24	25	26
	CODE	How many <u>male</u> family members and non-family members are currently living in the household?	How many <u>male</u> family members and non-family members living in the household are currently involved in aquaculture, trading, and/or processing activities for your farm?	How many <u>female</u> family members and non-family members are currently living in the household?	How many <u>female</u> family members and non-family members living in the household are currently involved in aquaculture, trading, and/or processing activities for your farm?
		Number	Number	Number	Number
Children 0-14 years	1				
Age 15 – 29	2				
Age >=30	3				

B2. LONG TERM EMPLOYEE STATUS

NOTE: I am now going to ask you a number of questions about the persons who have been working for a long period of time on your farm. Please note that we are only interested in those who worked on your farm in 2018.

27. How many long-term (**more than 3 months**) employees or casual laborers did you employ during 2018?

__ __ __ persons If NO >> Module B3

28	29	30	31	32
CODE	Gender 1=female 2=male	Age 1=15-29 years 2= over 30 years	Types of labor 1=full time 2=part time	How many days did they work on your farms in 2018? (days)
1				
2				
3				
4				

IF Q17 is FEED MILL (7) >> MODULE M

If Q17 is MFI (8) >>> MODULE N

IF Q17 is 1,2,3,4,5,6,9 >>> MODULE B3

B3. HIRED CASUAL LABOR

NOTE: I am now going to ask you a number of questions about the type and number of persons working for short-term periods on your farm or at your business. Please note that we are only interested in those who worked on your farm in 2018.

32.1. How many short-term male workers (casual labor) did you hire in 2018?

32.2. How many short-term male workers over 30 years old?

33. How many days in 2018 did you employ one or more short-term male workers to perform casual labor? Please make your best estimate.

34.1. How many short-term female workers (casual labor) did you hire in 2018?

34.2. How many short-term female workers over 30 years old?

35. On average, how many days in 2018 did you employ one or more short-term female workers to perform casual labor?

Note for the enumerator: On fish farms, nurseries, and hatcheries – or at collectors, processors, and wholesalers – hired labor can be for pond or cage construction or repair. Examples of this include, but are not limited to, a) buying fish seed or stocking fish seed into the pond or cage; b) buying, transporting, or hauling fish feed to the farm; c) breeding, feeding, or harvesting fish; and/or d) loading, unloading, bagging, transport, filleting, drying, or icing fish.

NOTE: I am now going to ask you a number of questions about the activities of the different types of employees on your farm or business. As discussed, the types of employees identified for this survey include household members, long-term employees, and short-term hired laborers. Please answer all questions openly and honestly. Do you have any questions?

What activities are household members, long-term employees, and short-term hired laborers involved in?

		36	37
	Code	Family members and long-term employees 1= Yes 2= No	Short-term hired laborers 1= Yes 2= No
Loading/ unloading/ bagging/ transport/ other (materials)	1		
Pond/ cage construction or repair	2		
Buying fish seed or stocking fish seed into the pond/cage	3		
Buying/ transporting/ hauling fish feed to the farm	4		
Breeding (for hatcheries and nurseries only)	5		
Feeding fish	6		
Guarding ponds/ cage	7		
Harvesting fish/ hauling from farm/ transporting to market	8		
Pond/ cage management	9		
Other (specify) _____	99		
Other (specify) _____	99		
Other (specify) _____			

MODULE C: FARM ASSETS

ANSWER THIS ONLY IF Q17 is 1 (HATCHERY), 2 (NURSERY) or 3 (PRODUCER).

IF Q17 is 4, 5, 6, 9>> MODULE D

NOTE: I am now going to ask you a number of questions about the type and quantity of equipment currently available on this farm. Please note that we are interested in your current situation, not past experiences or future plans.

C1. POND-CAGE ROSTER

38. Total area of the farm (m²): _____ (including buildings for hatcheries, nurseries)

39: What is the area (m²) of buildings and other above-ground structures currently being used for hatcheries and/or nurseries?
_____m²

INSTRUCTION TO ENUMERATORS

Ask the farmer, with the help of enumerator, to draw a diagram of all the ponds and cages in their holdings. Draw ponds that have been in operation since 2018. Each pond and cage should be numbered, and the main pond or cage should be identified as n^o1.

*Ask the farmer, with the help of enumerator, to note the length, width, and depth of each pond and all cages on the diagram. Proceed unit per unit, indicating the dimensions on the diagram, in meters. **Indicate the area (m²) or volume (m³) on each unit – you will need it later in Module G***

If there are too many units, draw one unit for each type of pond or cage of similar size and indicate the number of similar unit.

Identify the main cage or pond on the map by a “1”. By main cage/pond refers the cage/pond that provides the highest revenue in the farm..

Number the different units (pond or cage), starting from 2.

DRAW AND TAKE A PHOTO OF THE DIAGRAM

40. From 2018 until now, have you used cages, ponds or both to raise fish? (1= cage; 2= pond; 3= both): |__|

41: How many cages have you operated from 2018 until now?: |_____|

42: How many pond have you operated from 2018 until now?: |_____|

NOTE: For each type of pond or cage, detail the size of the unit, and ask how many similar units the farmer operates

43		49	44	45	46	47	48
Pond or cage number	Type of pond/cage (operating in 2018) 1= Grow-out pond 2= Nursery pond 3= Grow-out cage 4= Nursery cage 5= Broodfish pond (if Q17 is 1)	How many units of the same size do you operate?	What is the length of the pond/cage? (m)	What is the width of the pond/cage? (m)	What is the depth of the pond/cage? (m)	Main fish species that have already been harvested (last production cycle) between 2018 and now If Q43= 1 or Q43= 3 1= Pangasius 2= Clarias/walking 3= catfish 4= Red Tilapia 5= Nile Tilapia 6= Channa striata 7=Channa micropeltes 8= Annabas 9= Snakeskin 10= Gourami 11= Red Tail catfish Silver barb Carp species 99= Other (specify)	In what year was this pond/cage constructed?
						If Q43=1 or Q43= 3	
1							
2							

3							
4							
5							
6							
7							

50. (If Q17=1) How many tanks did you operate in 2018? | _____ | (if Q50=0 >> Q58)

NOTE: List the different types and sizes of operational tanks that the farmer owns. For each type and size of tank, (rectangular or circular), ask how many similar units the farmer owns and detail the size of the unit.

51		52	53	54	55	57
Tank number	Type of tank 1= square or rectangular tank 2= circular tank	How many unit of the same size do you operate	What is the length or diameter (if circular) of the tank? (m)	What is the width of the tank? (m) If 2 in Q51 >>55	What is the depth of the tank? (m)	In what year was the latest tank constructed or bought?
		Number				YYYY
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						

C2. WATER SOURCE (if Q40=2 or 3 >> Q58; if Q40=1 >> Q63)

58. What is the main water source for your ponds?: (1: RIVER, STREAM; 2: PUBLIC RESERVOIR; 3: PRIVATE RESERVOIR OR POND; 4: WELL ; 5: IRRIGATION CANAL; 6 :RAIN; 7: OTHER (SPECIFY); 98: N/A, 97: DON'T KNOW):

59. If Q58= 4 What is the approximate depth of the well? _____meters; If Q58 not 4 , then >>next

60. Is water available and sufficient to raise fish all year round (1=YES; 2= NO; 98: N/A, 97: DON'T KNOW):

61. What additional support do you need to ensure consistent availability of and better access to water on your farm?

(1: DIG A WELL; 2: DEEPEN EXISTING WELL; 3: DIG A RESERVOIR; 4: IMPROVE EXISTING CANAL; 5: CONNECT TO CANAL; 99 OTHER SPECIFY; 98: N/A, 97: DON'T KNOW):

C3.EQUIPMENT (If Q40= 2 or 3 >> Q63, If Q40= 1 >>Q66)

63. How many water pumps do you own? (97= DON'T KNOW),

64. How many water pumps do you rent? (97= DON'T KNOW)

If Q63= 0 and Q64=0 >> Q67

65. How many horsepower (HP) is the largest water pump that you own or rent? HP (97= DON'T KNOW)

66. Do you own or rent this piece of equipment? (1= OWN; 2=RENT; 97= DON'T KNOW)

67. How many of the ponds or cages are aerated currently (paddle wheels or aerator)? (97= DON'T KNOW) If Q67 not 0 >> Q67.1 and Q67.2

67.1 (203) When did you purchase this aeration equipment? : _____Years (97 =DON'T KNOW)

67.2 (204) How much did this aeration equipment cost?: _____KHR (97 =DON'T KNOW)

68. Do you operate a homemade feed cooker to make fish feed?: (1= YES; 2= NO; 3= DON'T KNOW):_

If Q17 is 1 (Hatchery) or 2 (Nursery), then Q69 ;

NO>> MODULE D

69. Please list down equipment that is currently owned and functional

CODE		Tick boxes
	Equipment	
1	Oxygen Tank	
2	Larval rearing cones	
3	Tank	
4	Refrigerator (for hormones)	
5	Scale	
6	Grader	
7	Hauling tanks with oxygen	
8	Hapa	
9	Seine net for harvest	
10	Secchi disk	
11	Dip net	
99	None	

MODULE D. EQUIPMENT, ASSETS AND DISTRIBUTION CAPACITY IN POST HARVEST

If Q17 is 4 (Collector), 5 (Wholesaler) or 6 (Processors) or 9 (Feed distributor), >>> Q72

NO >> MODULE E

NOTE: I am now going to ask you a number of questions about the type and quantity of equipment currently available to this business. Please note that we are interested in the current situation, not past or future plans for equipment use.

72. How many buildings used as warehouses (for storage and/or processing) or shops do you own?

CODE	73. What is the surface of the building (m ²)?
1	
2	
3	
4	
5	

IF Q17 is 9 >> Q82

[Skip if Q17=9 (Feed distributor)]

Do you have the following equipment for your wholesale, trading or processing activities?

CODE		79	80
		Number of units	Size of 1 unit (indicate the largest one if different dimensions) (Skip if Q79=0)
			97: DON'T KNOW, 98: N/A
1	Refrigerator (m3)		
2	Generator (HP)		
3	Ice crusher (Skip Q80)		
4	Tanks for live fish & transportation with aeration (m3)		
5	Tanks for live fish & transportation - no aeration (m3)		
6	Tanks for transporting chilled/dead fish (m3)		
7	Cool box/insulated box (m3)		
8	Baskets (bamboo or plastic) (m3)		
9	Solar dryer (m2)		
10	Stove to smoke fish (m3)		
11	Other (specify)		
12	Other (specify)		
13	Other (specify)		
14	Other (specify)		

84. Do you have the following means of transportation for your wholesale, trading or processing activities?

		Number of units
1	Motorcycle ('moto')	
2	Cart/trailer (attached to moto)	
3	Car (sedan)	
4	Boat (motorized)	
5	Mini-van (e.g. Ssanyong)	
6	Small truck & pickup (4 wheels)	
7	Large truck (6 wheels and more)	
8	Other (specify)	
9	Other (specify)	
10	Other (specify)	

MODULE E. HATCHERIES PRODUCTION

If Q17 is 1 (HATCHERY) then >>Q85-Q105

If ≠ >> MODULE F

NOTE: I am now going to ask you a number of questions about the inputs used by the hatchery, and the production of the hatchery. Please note that we are interested in the 2018 production cycle. Our questions concern the activities of the whole hatchery, and do not concern only a specific pond.

In 2018:

85. When did the peak spawning period start?

85.1 MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

85.2 WW (1 WEEK 1; 2 WEEK 2; 3 WEEK 3; 4 WEEK 4; 97= DON'T KNOW)

86. When did the peak spawning period end?

86.1 MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

86.2 WW (1 WEEK 1; 2 WEEK 2; 3 WEEK 3; 4 WEEK 4; 97= DON'T KNOW)

87. When does the peak selling period start?

87.1 MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

87.2 WW (1 WEEK 1; 2 WEEK 2; 3 WEEK 3; 4 WEEK 4; 97= DON'T KNOW)

88. When does the peak selling period end?

88.1 MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW) |____|

88.2 WW (1 WEEK 1; 2 WEEK 2; 3 WEEK 3; 4 WEEK 4; 97= DON'T KNOW) |____|

89. Are you able to meet demand for your product(s) during the peak season? (1: YES; 2= NO; 97= DON'T KNOW): |____|

90. When was the first time you started to sell fingerlings in 2018? Month |____| 1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

91. When was the last time you sold fingerlings from your hatcheries in 2018? Month |____| 1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

E1: Production

NOTE: The following questions concern the 2018 production cycle, and concern the activities of the whole hatchery and not only of a specific pond

92		93	94	95	96	98	98.1
		What was the total quantity of [..species..] produced in 2018?	How many breeding cycles did you perform per species in 2018?	What was the total quantity of [..species..] sold in 2018?	What was the average price sold for [..species..] in 2018?	Size of fingerlings sold	Unit
CODE		number If 0 >> NEXT ITEM	number	number	KHR/ind		1= cm/ind 2= g/ind
Pangasius	1						
Clarias/walking catfish	2						
Red tilapia	3						
Nile tilapia	4						
Channa striata	5						
Channa micropeltes	6						
Annabas	7						
Snakeskin gourami	8						
Redtail catfish	9						
Silver barb	10						
Carp species	11						
Other (specify)	99						
Other (specify)	99						
Other (specify)	99						

100. What is the average survival rate during nursing (for hatchery)? _____% (97= DON'T KNOW) (Rule: between 0 and 100)

101. Where is the main destination of the production from your hatchery? (1: THIS VILLAGE; 2: THIS COMMUNE; 3: NEIGHBORING COMMUNE; 4: OTHER DISTRICT IN THE PROVINCE; 5: OTHER PROVINCE; 99: OTHER SPECIFY):

E2: SALES

NOTE: I am now going to ask you a number of questions about the value of sales from your hatchery. Please note that we are only interested in the 2018 production cycle. Our questions concern the activities of the whole hatchery, and not only of a specific pond

		103	104	105
		Did you sell fingerlings to the following type of buyer?	How many different types of buyers did you sell to during 2018?	How often did you receive cash advance from this type of buyer in 2018?
	Code	1= YES 2= NO If no >>> NEXT ITEM	NUMBER	1= NEVER 2= SOMETIMES 3= ALWAYS
Fish farmer	1			
Fingerling traders	2			
Nurseries	3			
Other (specify)	99			

MODULE F: NURSERIES

If Q17 is 2 (Nursery), then >>Q106-Q130

If #>> MODULE G

NOTE: I am now going to ask you a number of questions about the production and sales of the nursery. Please note that we are interested in the 2018 production cycle. Our questions concern the activities of the whole nursery

In 2018:

106. When did the peak stocking period start?

106.1 MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

106.2 WW (1 WEEK 1; 2 WEEK 2; 3 WEEK 3; 4 WEEK 4)

107. When did the peak stocking period end?

107.1 MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

107.2 WW (1 WEEK 1; 2 WEEK 2; 3 WEEK 3; 4 WEEK 4)

108. When did the peak selling period start?

108.1 MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

108.2 WW (1 WEEK 1; 2 WEEK 2; 3 WEEK 3 ; 4 WEEK 4)

109. When did the peak selling period end?

109.1 MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW)

109.2 WW (1 WEEK 1; 2 WEEK 2; 3 WEEK 3; 4 WEEK 4)

110. When was the first time you stocked your nursery in 2018? MONTH (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW; 98=N/A)

113. When was the last time you harvested and sold fish from your nursery in 2018? MONTH (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97= DON'T KNOW; 98=N/A)

F1. STOCKING

NOTE: The following questions concern the 2018 production cycle and concern the activities of the whole nursery, and not only of a specific pond.

		115	116	116.1	117
		Did you stock [..species..] during 2018?	Quantity of [..species..] stocked in 2018	Unit	Unit price
	CODE	1 YES 2 NO >> NEXT ITEM	NUMBER 97: DON'T KNOW	1 IND 2. KG	KHR/Unit 97: DON'T KNOW
Pangasius	1				
Clarias/walking catfish	2				
Red tilapia	3				
Nile tilapia	4				
Channa striata	5				
Channa micropeltes	6				
Annabas	7				
Snakeskin gourami	8				
Redtail catfish	9				
Silver barb	10				
Carp species	11				
Other (specify)	99				
Other (specify)	99				
Other (specify)	99				

118. In general, from whom did you obtain your fingerlings in 2018: 1: PRIVATE HATCHERY; 2: FINGERLING TRADER SOURCING MATERIAL FROM CAMBODIA; 3: FIA HATCHERY; 4: CAUGHT FROM RIVER; 5: NGO; 6: FINGERLINGS TRADER SOURCING MATERIAL FROM VIETNAM OR THAILAND; 99 OTHER (SPECIFY):

119. What was the average number of days between purchase and re-sell (i.e., nursing period)? days (97= DON'T KNOW) (Rule: not more than 120 days)

120: How many fingerlings per square meter do you typically stock? ind/m² (97= DON'T KNOW)

121. What is the average survival rate during nursing (for nursery)? % (97= DON'T KNOW) (Rule: between 0 and 100)

122. How many nursing cycles were completed in 2018? (97= DON'T KNOW)

F2. DISTRIBUTION

NOTE: I am now going to ask you a number of questions about the sales of the nursery. Please note that we are interested in 2018 sales activities. Our questions concern the activities of the whole nursery and not only a specific pond.

		124	125	125.1	126	127	128	128.1
		Did you sell any of [..species..] in 2018?	What was the total quantity of [..species..] sold in 2018?	Unit	What was the average price sold for [..species..]?	What was the total sales value in 2018 ?	What was the average size of fingerlings when sold?	Unit
	CODE	1 YES 2 NO >> NEXT ITEM	NUMBER 97: DON'T KNOW	1 IND 2: KG	KHR/Unit 97: DON'T KNOW	KHR 97: DON'T KNOW	1 HATCHLING 2. <1 3. 1-3 4. 3-5 5. 5-7 6. 7-10 7. >10	1= g 2= cm
Pangasius	1							
Clarias/walking catfish	2							
Red tilapia	3							
Nile tilapia	4							
Channa striata	5							
Channa micropeltes	6							
Annabas	7							
Snakeskin gourami	8							
Redtail catfish	9							
Silver barb	10							
Carp species	11							
Other (specify)	99							
Other (specify)	99							

129. Which type of buyer purchases the majority of your fingerlings? 1: OTHER NURSERIES; 2: FINGERLING TRADER(S); 3: SMALL GROW-OUT FARM(S) (LESS THAN 200 M² POND- 30 M³ CAGE); 4: MEDIUM/ LARGE GROW-OUT FARM; 99: OTHER SPECIFY:

130. Are you responsible for the transportation of your fingerlings to the buyer(s)? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

MODULE G: PRODUCERS

IF Q17 is 3 (Producers) ONLY, then>>Q131

IF Q17 is 1, 2 AND Q19 is 1 (YES) (HATCHERY or NURSERY ALSO RAISING FISH FOR MARKET),then
>>Q131

IF NO to Q19 or Q17 is ≠ 3 >> MODULE H

NOTE: I am now going to ask you a number of questions about the stocking and production of the farm. Please note that we are interested in the last year – i.e. activities in 2018. To identify the production cycles and production calendar, we will ask you question about stocking and harvesting since 2017.

- *Talk to the informant to identify the beginning and end of the last complete production cycle and the different production cycles starting from May 2017 up to April 2019. Identify the stocking and harvesting calendar(s) for the main pond or cage of the farm. Use the map of the farm ponds and cages (Module C) where the main pond or cage is identified.*
- *A production cycle finishes when all of the main species in the pond have been harvested.*
- *A production cycle begins when the pond is restocked after the main species in the pond have been harvested.*

ON a HARDCOPY - Ask in which months the main pond or cage (i.e. the cage/pond that provides the highest revenue for the farm) was stocked (indicate with 'S'), and in which month the main pond was harvested (indicate with 'H') within the last **24 months**.

	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
Month	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Year	17	17	17	17	17	17	17	18	18	18	18	18	18	18	18	18	18	18	18	19	19	19	19	19
Stocked																								
Harvested																								

Using the table above, count:

131. How many production cycles were completed in the past 24 months? |____|

132. How many production cycles were completed in the past 12 months (since 1 June 2018)? |____|

133. How many production cycles were completed in 2018? |____|

134.1. When did the last complete production cycle begin? YEAR |____| (1= 2017; 2= 2018; 3= 2019)

134.2. MONTH |____| (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER)

135.1. When did the last complete production cycle end? YEAR |____| (1= 2017; 2= 2018; 3= 2019)

135.2. MONTH |____| (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER)

G1. STOCKING (Reference to Q47.1 above)

NOTE: All questions in this module relate to the whole farm and concern the last complete production cycle. Use the diagram made in POND/CAGE ROSTER (Module C) to identify which pond is stocked with which species.

136		137	143	143_unit	145	145_unit	146
Species stocked		Did you stock [..species..] during in last completed cycle?	Quantity of [..species..] stocked per cycle		Average size at stocking		Unit price (of Q143)
	CODE	1 YES 2 NO	NUMBER	UNIT 1= IND 2= KG	Size 1. HATCHLING 2. <1 3. 1-3 4. 3-5 5. 5-7 6. 7-10 7. >10	Unit 1= g 2= cm	KHR
Pangasius	1						
Clarias/walking catfish	2						
Red tilapia	3						
Nile tilapia	4						
Channa striata	5						
Channa micropeltes	6						
Annabas	7						
Snakeskin gourami	8						
Redtail catfish	9						
Silver barb	10						
Carp species	11						
Other (specify)	99						

147. Were all fingerlings of a very similar size? (1: YES; 2= NO; 97= DON'T KNOW):

148. What is the main source of fingerlings: 1.FINGERLING TRADER CAMBODIA; 2.OWN NURSERY POND; 3. PRIVATE NURSERY; 4. OWN HATCHERY; 5. FIA HATCHERY ; 6. PRIVATE HATCHERY CAMBODIA; 7. WILD CAUGHT; 8. NGO; 9: NEIGHBORS; 10: FINGERLING TRADER OR NURSERY SOURCING FROM VIETNAM OR THAILAND; 99 OTHER (SPECIFY) :

G2. GROWOUT - FEED INPUTS (Focus on the main the volume of fish species for last completed production cycle for all ponds/cages)

IF Q17 is 3 (Producers) ONLY, >>Q149

If #>>MODULE G3

NOTE: I am now going to ask you a number of questions about your use of feed during the last complete production cycle. NOTE: Remind the informant: all questions in this module relate to the last complete production cycle.

149		150	151	151_unit	152	152_unit	153	154	155	156	157
Input used		Did you use [..input..] during the last completed production cycle?	What was the total quantity of [..feed..] used at the farm during the last completed production cycle?		What was the average price per unit of [..feed..]? (KHR)		Protein content of comm ercial feed	From what source did you obtain [..feed..]?	Did you receive any [..feed..] on credit or as in- kind from this supplier?	If YES in 155 How much feed did you receive on credit? % of total Quantity (Q145)	If YES in 155 Were you obligated to sell harvested fish to this supplier, or a trader linked to this supplier?
	CODE	1 YES	AMOUNT	UNIT	AMOUNT	PER..	97:DON'T KNOW	1 FEED DEALER (MANUFACT OR)	1 YES	IF NO>>	1 YES
		2 NO		1 KG		1 KG	%	2 TRASH Fish TRADER	2 NO	>> NEXT ITEM	2 NO
		>> NEXT		2 M TONS		2 M TONS		3 OTHER FARMER			
		ITEM		3 BAG		3 BAG		4 FISHERMEN			
				99 OTHER		99 OTHER		5. OWN PRODUCTIO N			
				(SPECIFY)		(SPECIFY)		6. RICE MILL			
								97. DON'T KNOW			
						98 N/A		99. OTHER (SPECIFY)			
Sinking feed (pellet)	1										
Floating feed (pellet)	2										
Trash fish only	3										
Homemade feed with trash fish (processed)	4										
Homemade feed without trash fish	5										
Other (specify)	99										

G3. GROWOUT – HARVESTING (Focus on the main volume of fish species for the last completed production cycle for all ponds/cages)

IF Q17 is 3 (producers) ONLY, >> Q149

IF Q17 is 1, 2 AND Q19 is 1 (YES) (HATCHERY or NURSERY ALSO RAISING FISH FOR MARKET), >>Q158

IF NO to Q19 or Q17 is ≠ 3 >> MODULE H

NOTE: I am now going to ask you a number of questions about harvesting and sales during the last complete production cycle.

		160	162	164	165
Species harvested during the last completed cycle		What was the total quantity of [...species...] during the last completed production cycle?	What was the average price received per kg for [...species...] during the last completed production cycle?	Sold as (main product in term of volume)	Over how many days did you harvest the fish?
CODE		97: DON'T KNOW KG	97: DON'T KNOW KHR/KG	1= WHOLE FISH (LIVE) 2=WHOLE FISH DEAD 3= BE-HEADED & GUTTED 4= DRIED/SMOKED/SALTED FISH 5= FERMENTED FISH	1= 1 DAY 2= 2 TO 5 DAYS
					3= 6 TO 9 DAYS
					4= 10 TO 20 DAYS
					5= >20 DAYS
Pangasius	1				
Clarias/walking catfish	2				
Red tilapia	3				
Nile tilapia	4				
Channa striata	5				
Channa micropeltes	6				
Annabas	7				
Snakeskin gourami	8				
Redtail catfish	9				
Silver barb	10				
Carp species	11				
Other (specify)	99				
Other (specify)	99				
Other (specify)	99				

G4. GROWOUT – SALES (Last completed production cycle for all pond/cage)

IF Q17 is 3 (Producers), then>>166

IF Q17 is 1, 2 AND Q19 is 1 (YES) (HATCHERY or NURSERY ALSO RAISING FISH FOR MARKET), then >>Q166

IF NO to Q19 or Q17 is ≠ 3 >> MODULE H

NOTE: I am now going to ask you a number of questions about sales during the last complete production cycle (i.e. the last harvest).

NOTES: Remind the informant: all questions in this module relate to the farm production and sales during the last complete production cycle.

166		167	168	169
Type of customers		Did you sell fish to the following type of buyer? 1= YES 2= NO (>> Q168 and Q169)	How many different buyers did you sell fish to after the last complete production cycle? NUMBER	Did you receive any cash advance from this type of buyer after the complete cycle? 1= YES 2= NO
	CODE			
Collector	1			
Feed company/Fish distributor	2			
Processor	3			
Wholesaler	4			
Retail shop/Market/Supper market	5			
Consumer	6			
Other (specify)	99			

NOTE: At this point, we are at the halfway to the end of the interview. You can have a short break before we continue

H. MANAGEMENT PRACTICES

IF Q17 is 1 (Hatchery) >> MODULE H1-H2-H3-H4-H5-H9.1-H10

IF Q17 is 2 (Nursery) >> MODULE H3-H4-H5-H9.1-H10

IF Q17 is 3 (Producer) >> MODULE H5

IF Q17 is 4,5,6 (Collector, Wholesaler, Processor) >> MODULE H9

NOTE: I am now going to ask you a number of questions about your current management techniques in your hatchery.

H1.BROODSTOCK MANAGEMENT

IF Q17 is 1 (Hatchery)

171. Do you know how to estimate the number of fry to transfer to a nursing pond (1=YES; 2= NO; 3= NOT SURE):

172. Do you know the fecundity (number of eggs per fish) of your broodfish (1=YES; 2= NO; 3= NOT SURE):

		174
-(Reference from Q93)		Origin of broodfish For species produced in 2018
		1= WILD
	CODE	2 = PRIVATE CAMBODIAN HATCHERY
		3= FIA HATCHERY
		4 = OWN SELECTION
		5= OUTSIDE OF CAMBODIA
		99= OTHER SPECIFY
Pangasius	1	
Clarias/walking catfish	2	
Red tilapia	3	
Nile tilapia	4	
Channa striata	5	
Channa micropeltes	6	
Annabas	7	
Snakeskin gourami	8	
Redtail catfish	9	
Silver barb	10	
Carp species	11	
Other (specify)	99	
Other (specify)	99	
Other (specify)	99	

175. During how many years have you used the same broodfish for breeding? Years (97= DON'T' KNOW)

176. Are your fingerlings certified or do they have a quality seal? (1= YES; 2= NO): IF NO>>> Q178 & If 176 is YES>> Q177

177. What certification or quality seal did they receive? (97: DON'T' KNOW)

178. What is the MAIN type of feed you are using for broodfish: (1: FLOATING PELLETT; 2: SINKING PELLETT; 3: TRASH FISH ONLY; 4: HOMEMADE FEED WITH TRASH FISH (PROCESSED) 5: HOMEMADE FEED WITHOUT TRASH FISH; 6: COMMERCIAL FEED MIXED WITH HOMEMADE FEED WITH OR WITHOUT TRASH FISH; 97: DON'T' KNOW; 98: N/A; 99: OTHER (SPECIFY)):

If Q178 is 1 or 2 >>Q179; otherwise >> Module H2

179 What is the percent of protein in the commercial diet? (97 = DON'T KNOW)

180. What is the amount of feed given per day in terms of the percent of fish body weight? % of fish body weight (97 = DON'T KNOW)

H2. BIOSECURITY MEASURES

IF Q17 is 1 (Hatchery)

NOTE: I am now going to ask you a number of questions about your current biosecurity measures in your hatchery or nursery.

181. For newly-purchased broodfish, do you apply a quarantine period in a separate pond from your current broodfish? (1: YES; 2= NO):

182. Do you check for parasites on broodfish? (1: YES; 2= NO):

183. How often do you clean your hatchery equipment? (1= never; 2= once a year; 3= after every use; 99= other –specify)

184. What do you use to clean nets and/or tanks? (1: soap- detergent; 2: bleach; 3 water only; 99 other –specify)

H3. NURSING

If Q17 is 1 (Hatchery) or 2 (Nursery)

NOTE: I am now going to ask you a number of questions about your current nursing techniques in your hatchery or nursery.

185. In nursing ponds, how often do you use burned lime or chemicals to control predators? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):
|____|

186. What is the stocking density in the nursing pond or tank? _____ (UNIT: FRY/M²; 97 =DON'T KNOW)

187. How often do you grade the fingerlings before selling? (1= NEVER; 2= SOMETIMES; 3= ALWAYS): |____| If NEVER in 187>> Q189

188. How do you grade the fingerlings? (1: VISUAL CHECK; 2: USING GRADER; 3: BOTH; 99 OTHER SPECIFY) |____|

189. What is the MAIN type of feed you are using for fingerlings? (1: FLOATING PELLET; 2: SINKING PELLET; 3: TRASH FISH ONLY; 4: HOMEMADE FEED WITH TRASH FISH (PROCESSED) 5: HOMEMADE FEED WITHOUT TRASH FISH; 6: COMMERCIAL FEED MIXED WITH HOMEMADE FEED WITH OR WITHOUT TRASH FISH; 7: MANUFACTURED POWDER OR CRUMBLE; 97 =DON'T KNOW; 99:OTHER (SPECIFY)):_____

H4. TRANSPORT

If Q17 is 1 (Hatchery) or 2 (Nursery)

190. Do you transport fingerlings in (Tick boxes – multiple choice possible):

1: Plastic bags with oxygen: 1 = YES 2 = NO: |____|

2: Plastic bag with air: 1 = YES 2 = NO |____|

3: Hauling tanks with aeration or oxygen: 1 = YES 2 = NO: |____|

4: Car trunk or small dump truck with plastic liner: 1 = YES 2 = NO: |____|

99: Other (specify): _____

191. Do you stop feeding fingerlings before transporting them? (1=YES; 2= NO): |_____| If NO>>Q193

IF 191 is YES >>Q192

192 How many hours before transporting the fingerlings do you stop feeding them? |_____| Hours (97 =DON'T KNOW)

Note to enumerators: Enumerators need to enter the answer in number of HOURS. If respondent answers in numbers of days: 1 day = 24 hours. In general, transport of fingerlings is less than 24 hours.

193 Are you in charge of transporting fingerlings? (1= NEVER; 2= SOMETIMES; 3= ALWAYS): |_____| if Sometimes or Always>>Q195

IF YES to 193 >>Q194

194 Average mortality rate during transport (%) |_____| (97 =DON'T KNOW)

195. On average, how many hours does it take to transport the fingerlings from your nursery pond(s) to their final destination? |_____| hours (97 =DON'T KNOW)

Note to enumerators: Enumerators need to enter the answer in number of HOURS. If respondent answers in numbers of days: 1 day = 24 hours. In general, transport of fingerlings is less than 24 hours.

H5. CLIMATE CHANGE

If Q17 is 1 (Hatchery), 2 (Nursery) or 3 (Producers), then>>196

IF Q17 ≠ 1, 2,3 >> MODULE H9

NOTE: I am now going to ask you a number of questions about your management techniques in your farm, regarding flooding, drought and access to water

196. How many times in the last 5 years were your pond(s) or cage(s) affected by flooding? By affected by flooding, we mean that flood waters caused your pond(s) to overflow or damaged your cage(s), resulting in fish escaping. |_____| time(s) (97 =DON'T KNOW)

197. Are your pond(s) fenced? (1=YES/2= NO)

198. How many times in the last 5 years were your pond(s) or cage(s) affected by drought? By affected by drought, we mean that the water level was so low that fish started dying, and fish had to be harvested earlier than the expected harvest date. time (97 =DON'T KNOW)

199. Did you invest in well(s) to supply water? (1=YES; 2= NO): if YES>>201

If 199 is NO>> 200:

200. Why did you NOT invest in a well: (1: LACK OF FUNDS; 2: DO NOT KNOW SOMEONE WHO CAN DIG THE WELL; 3: ARSENIC POLLUTION IN GROUNDWATER; 4: WATER TABLE IS TOO DEEP; 99: OTHER SPECIFY)

If Q17 is 3 (Producers) ONLY, >>201

IF Q17 ≠ 3 >> MODULE H9

201: Do you grow short-cycle fish species? (3 months or less) (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

202: Do you target small harvest sizes (150 grams per fish) to shorten the production cycle? (1= NEVER; 2= SOMETIMES; 3= ALWAYS)

205 Do you move the cage during the dry season? (1=YES; 2= NO;):

H6. STOCKING AND POND PREPARATION

If Q17 is 3 (Producers) ONLY, then>>Q206

IF Q17 ≠ 3 >> MODULE H9

NOTE: I am now going to ask you a number of questions about the pond preparation and stocking management techniques you currently use on your farm.

206. Do you dry out the pond between production cycles? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

207. Do you use burned lime or chemicals to control predators? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

208. What is your average mortality rate during transport between hatchery/nursery and your pond? (%) (97 =DON'T KNOW)
(Rule: between 0 and 100)

209. Do you stock fingerlings in hapas for nursing? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

210. Are your fingerlings certified, or do they have a quality seal? (1= NEVER; 2= SOMETIMES; 3= ALWAYS): if Q210= 2 or3
>>Q211

If 210 is 2-SOMETIMES or 3 ALWAYS >> Q211

211. What certification have your fingerlings received or which quality seal do they have?: _____

H7 WATER MANAGEMENT

If Q17 is 3 (Producers) ONLY, then>> 212

IF Q17 ≠ 3 >> MODULE H9

212: Do you use a Secchi disk to measure water turbidity? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

213: Do you use a D.O. meter? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

214: Do you use a Water quality test kit? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

215. Do you use agricultural lime or dolomite during pond preparation and/or while fish are being grown? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

216. Do you use inorganic fertilizer (DAP, TSP, Urea, NPK) to improve water quality during pond preparation and while fish are being grown? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

217. Do you use organic fertilizer (manure, compost) to improve water quality during pond preparation and while fish are being grown? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

H8. FEED MANAGEMENT

If Q17 is 3 (Producers) ONLY, then>> 218

IF Q17 ≠ 3 >> MODULE H9

219 Do you use a feed table to estimate how much feed per day you should give to the fish? (1=YES; 2= NO; 97= DON'T KNOW):

220: For the main fish species you raise in your farm, how many different pellet sizes are you are using during a production cycle?
Number of pellet size (Rules between 1 and 8) (97= DON'T KNOW)

220.1: Do you know when the commercial feed was manufactured? (1=YES; 2= NO):

221: Do you have dry storage for the commercial feed (1=YES; 2= NO):

222: What is the name of the feed manufacturer you use? (select only one answer) (1: OCIALIS; 2 LY HONG CHOY; 3 AGRI-MASTER; 4 DOLLAR; 5: GREEN FEED 6: CP; 99: OTHER (SPECIFY:) 97: DON'T KNOW):

223: Are you satisfied with the quality and price of the feed? (1=YES; 2= NO):

H9. SPS and Standards

H9.1. SPS and Standards for Hatchery and Nursery

If Q17 is 1 (Hatchery), 2 (Nursery), then>>224

NOTE: I am now going to ask you a number of questions about the management techniques you currently use in your hatchery or nursery. It concerns the techniques that affect the quality of your production, and the hygiene standards you currently apply in your hatchery or nursery.

224: Do you follow any technical quality recommendations or do you have a quality seal for your fingerlings? (1=YES; 2= NO; 97= DON'T KNOW): IF NO>>224 MODULE H10

If 224 is "YES">>Q225

225: specify the name of the recommendation they follow or the quality seal they received:_____

If 224 is "YES" >>Q226

226: From whom did you learn about this recommendation or receive this quality seal? (1= NGO- PROJECT; 2= FIA; 3= BUYER; 97= DON'T KNOW;

99 : OTHER – SPECIFY):_____

227: Do you know the strain of the broodfish you purchased? (1=YES; 2= NO) IF NO>>H10

If YES in 227>> Q228

228: Please specify the name of the strain _____

H9.2. SPS and Standards for Producer

If Q17 is 3 (Producers) ONLY, then>> 229

NOTE: I am now going to ask you a number of questions about the management techniques you currently use in your farm. It concerns the techniques that affect the quality of your production, and the hygiene standards you currently apply in your farm.

229. What do you do with dead fish from the pond? (1: PROCESS AND FEED TO OTHER FISH; 2: SELL; 3: CONSUME; 4: GIVE TO OTHER ANIMALS –DOG, CAT, SWINE ETC...; 5: BURY OR BURN; 99: OTHER SPECIFY):

230. Do you feed fish with waste from your harvest (head, guts etc...)? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

231: Do you follow any technical quality recommendations or have you received any quality seal for fish production? (1=YES; 2= NO; 97: DON'T KNOW): IF NO>> Q232, Q233

232. specify:_____

233. From whom did you learn about this recommendation or receive this quality seal? (1: NGO- PROJECT; 2: FIA; 3: BUYER; 97= DON'T KNOW; 99: OTHER (SPECIFY)):_____

H9.3. SPS and Standards for Collectors, Wholesalers and Processors

If Q17 is 4 (Collector), 5 (Wholesaler); 6 (Processor)

NOTE: I am now going to ask you a number of questions about the management techniques that you currently apply in your company. It concerns the quality of your production, and the hygiene standards that you currently apply in your farm.

234. Do you follow or apply any standard procedures when handling or processing fish? (1=YES ; 2=NO; 97= DON'T KNOW) |_____| If 2NO or 97 DON'T KNOW>>>Q237

If YES in 234 >>Q235

235. Specify the name of the standard procedure _____

If YES in 234>>Q236

236. Who supports this procedure? (1 GOVERNMENT; 2 PRIVATE COMPANY; 3 NGO; 4: OTHER (SPECIFY); 97: DON'T KNOW)
:_____

237. Do you know any Sanitary and Phyto-Sanitary practices? (1=YES ; 2=NO) |_____|

238. Do you use ice when storing dead fish? (1=YES; 2=NO; 98= N/A) |_____|

239. Do you use ice when transporting dead fish? (1=YES; 2=NO; 98= N/A):_____ IF NO or 97 in 238 or 239>> Q242

240. During the peak season of the aquaculture fish trade, how many kilograms of ice do you use PER DAY? _____KG/day (97= DON'T KNOW)

If YES in 238 or 239>>Q241;

241. Do you know if your ice is tested for chemical and microbial contaminants? (1=YES; 2=NO) |_____|

242. Do you use refrigerated trucks for transporting dead fish? (1=YES; 2=NO; 98= N/A):_____

243. Do you use a refrigerator for chilling and processing fish for storage? (1=YES; 2=NO; 98= N/A):_____ if NO or 97 in 243 >>245

If YES in 243>> Q244

244: How long on average are the fish kept in the refrigerators? _____DAYS (97= DON'T KNOW)

245. Do you record (in a book or on a computer) the origin of the fish you purchased? (1=YES; 2=NO; 97= DON'T KNOW) |_____|

H9.4. SPS and Standards for Wholesalers and Processors

If Q17 is 5 (Wholesaler); 6 (Processor)

246. How often do you and your employees wear gloves and masks when handling or processing fish? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |_____|

247. How often do you and your employees wash and disinfect your hands each time prior to starting their work? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |_____|

248. Do you have a constant supply of potable water? (1=YES; 2=NO; 97= DON'T KNOW) |_____|

249. Are raw products (e.g. fish) ever in direct contact with the floor? (1=YES; 2=NO; 97= DON'T KNOW) |_____|

250. How many times per week are the facilities and equipment cleaned? |_____| times (97: DON'T KNOW)

251. What do you use to clean equipment? (1: SOAP- DETERGENT; 2: BLEACH; 3 WATER ONLY; 99 OTHER (SPECIFY))

252. Do you have specific containers for storing the waste from processing fish? (1=YES; 2=NO; 97= DON'T KNOW) |_____| If Q252 is NO or 97>>Q254

If Q252 is YES>>Q253

253. Are those containers disinfected after each use? (1=YES; 2=NO; 97= DON'T KNOW) |_____|

254. Do you label your product with identification? (address, name of your business) (1=YES; 2=NO; 98= N/A)? |_____|

If NO>>Q258- Module H10 & If YES in Q254>> Q255

255. Do you add a manufacturing date on the product label? (1=YES; 2=NO) |_____|

256. Do you add an expiration date on the product label? (1=YES; 2=NO)

257. Do you add the origin of the fish on the product label? (1=YES; 2=NO)

H10. BUSINESS SKILLS

For beneficiaries: if Q17 is 1 Hatchery, 2 Nursery, 3 Producers, 4 Collectors, 5 Wholesalers, 6 Processors>> 259

NOTE: I am now going to ask you a number of questions about the business management techniques you currently use in your company or farm. It concerns how you plan your investment and finance.

260. Do you record the volume and costs of your inputs in a logbook? (1= YES; 2= NO)

261. Do you record your sales? (1=YES; 2=NO)

If Q17 is 1 (Hatcheries); 2 (Nurseries); 3 (Producers), >>262

If ≠ >>270

262 Do you know how much it costs to produce your fingerlings or fish? (1=YES; 2= NO): if Q262 NO>>264

If 262 is YES>> Q263

263. How much (KHR/ fish):_____ unit on average? (for producer)

263.1. How much (KHR/ fish):_____ unit on average? (for hatchery/nursery)

264. When you start the crop, do you have a target date to have fingerlings or fish ready? (1= NEVER; 2= SOMETIMES; 3= ALWAYS)

265. What type of contract/agreement do you have with buyers? (1= WRITTEN; 2= ORAL; 3= NO CONTRACT) |____| if Q265 is 3, >>>Q266-Q269

266. How many contracts/agreements were you able to fill in 2018? |____| (97: DON'T KNOW)

267. What was the average volume of each contract/agreement (for producers) in 2018? |____| (KG OF FISH PER CONTRACT)

267.1. What was the average volume of each contract/agreement (for hatchery/nursery) in 2018? |____| (# OF FINGERLINGS PER CONTRACT)

268. Did these contracts/agreements (in 2018) include delivery dates ? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |____|

269. Did these contracts/agreements (in 2018) include the size or weight of fingerlings/fish? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |____|

270. In 2018 did you limit your production because you could not sell all of your fingerlings/fish? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |____|

If Q17 is 3 (Producers), >>271

If ≠>>273

271: Do you have issues in reaching the minimum amount the buyer is requesting? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |____|

272: What is the minimum volume for one transaction when you sell in bulk? |____| kg/transaction (97= DON'T KNOW)

If Q17 is 4 (Collector), 5 (Wholesaler); 6 (Processor), then> Q273-Q290

If ≠>> MODULE I

273: Do you know in advance how much raw material (fish) you need to purchase for the month to come?

(1= NEVER; 2= SOMETIMES; 3= ALWAYS) |____|

274: Do you know in advance the cash return of your activity for the month to come? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |____|

275: Do you know the person or company that will purchase your product (fish or processed) before even sourcing the product?

(1= NEVER; 2= SOMETIMES; 3= ALWAYS):

Sourcing the material for trade and processing

NOTE: I am now going to ask you a number of questions about your current management techniques regarding buying fish from farmers or collectors.

276. How many fish farmers do you work with directly (buying directly from their farm)? (97= DON'T KNOW; 98= N/A)

277. How many fish buyers/collectors do you work with? (97= DON'T KNOW; 98= N/A)

278. How many fish importers do you work with? (97= DON'T KNOW; 98= N/A)

279. Do you loan cash or in-kind materials (feed, fingerlings) to fish farmers at the beginning of the cycle preceding the sales? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) If NEVER or 97 to Q279>>281

If ALWAYS or SOMETIMES in 279 >> Q280

280. Is the loan in: 1= CASH; 2=KIND; 3=BOTH?

Selling fish & processed fish

NOTE: I am now going to ask you a number of questions about your current management techniques regarding sales and trade of fish. I will ask about live fish, chilled (dead on ice) fish and processed fish. The following questions concern live, chilled (dead on ice) and processed fish

281. To how many regular buyers do you re-sell aquaculture fish or processed fish? (97: DON'T KNOW)

282. Do you have a contract/agreement with buyers (e.g. retailers, distributors) to sell them certain quantities of fish at certain times and for certain prices? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) IF 282 NEVER >> Q288

If 282 is ALWAYS or SOMETIMES >> Q283

283. What type of contract/agreement do you have with buyers? (1WRITTEN; 2 ORAL; 3 NO CONTRACT) If 283=3, Skip 284-286

284. How many contracts/agreements did you fill in 2018? (97= DON'T KNOW)

285. What was the average volume of fish sold per contract/agreement? (KG OF FISH PER CONTRACT): (98=N/A)

285.1. What was the average volume of processed fish sold per contract/agreement (KG OF PROCESSED FISH PER CONTRACT): (98=N/A)

286. Do the contracts/agreements include delivery dates? (1-YES 2-NO 97= DON'T KNOW)

287. Do you receive a loan from buyers at the beginning of the cycle preceding the sales? (1= NEVER; 2= SOMETIMES; 3= ALWAYS)

288. Do you limit your trade because you cannot source enough aquaculture fish? (1= NEVER; 2= SOMETIMES; 3= ALWAYS):

(If NEVER>>MODULE I) & If SOMETIMES/ALWAYS in Q288 >> 289

289. In which month of 2018 did the shortage of aquaculture fish start? MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER)

290. In which month of 2018 did the shortage of aquaculture fish end? MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER)

MODULE I. TRADE OF NON-PROCESSED & PROCESSED FISH

If Q17 is 4 (Collector) or 5 (Wholesaler), >> I1 (Q291)

NOTE: I am now going to ask you a number of questions about your fish trade in 2018 only. The following questions concern **ONLY chilled (dead on ice) and live fish from aquaculture**. We are talking about 2018 only and about aquaculture FISH only.

291.0. IF Q17 is 6 (Processor), >> Are you also buying and selling wet or chilled fish? 1-YES 2-NO |____|, if YES the I1-Q291, if NO>>> I3

FOR chilled (dead on ice) and live fish from aquaculture ONLY (not processed fish)

I1 CALENDAR

291: When did the peak season for Cambodian aquaculture fish trading start in 2018? |____| MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER 97-DON'T KNOW; 98= N/A)

292: When did the peak season for Cambodian aquaculture fish trading end in 2018? |____| MM (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER 97-DON'T KNOW; 98= N/A)

293: Rank the top THREE Aquaculture fish species in volume for wet or chilled market in 2018 (1 PANGASIU; 2 WALKING CATFISH-CLARIAS; 3 TILAPIA; 4 CARP SPECIES; 5 SILVER BARB; 6 CHANNA STRIATA; 7 CHANNA MICROPELTES; 97 DON'T KNOW; 99 OTHER SPECIFY):

293.1. 1st rank: _____

293.2. 2nd rank: _____

293.3. 3rd rank: _____

294: What was your maximum storage capacity in tons in 2018? |_____| tons

I2. COLLECTOR AND WHOLESALER BUYING AND SELLING ACTIVITIES

NOTE: The following questions concern last year – 2018. They concern buying and wholesale activities of chilled and live fish.

		296	297	298	299	300	301	302
		What was the total quantity of fish purchased in 2018 (both wild and aquaculture, local and imports)? (Metric tons)	From the total volume of fish purchased (Q296), how much comes from Cambodian Aquaculture in 2018?	What was the total the quantity of fish sold in 2018? (Metric tons)	What was the MINIMUM price sold per kg in 2018?	What was the MAXIMUM price sold per kg in 2018	What was the total value of fish sold in 2018	Where is the main destination of the production (1: THIS VILLAGE; 2: THIS COMMUNE; 3: NEIGHBORING COMMUNE; 4: PHNOM PENH; 5: OTHER DISTRICT IN THE PROVINCE; 6: OTHER PROVINCE; 7: EXPORT; 97:DON'T KNOW)
CODE		METRIC TONS 97:DON'T KNOW	METRIC TONS 97:DON'T KNOW	NUMBER 97:DON'T KNOW	KHR/KG	KHR/KG	KHR	
ALL FISH live or chilled (dead on ice)	1							
Pre-processed (gutted, head removed)	2							
Other (specify)	99							

303: Of the total volume of chilled (dead on ice) and live (wet) aquaculture fish you sold: what was the percentage of live fish: _____% (97=DON'T KNOW)

304: Of the total chilled (dead on ice) and live (wet) aquaculture fish you purchased: what was the percentage of fish permanently lost between procurement and sale due to spoilage/ rotting or similar _____% (97=DON'T KNOW)

305: Of the total chilled (dead on ice) and live aquaculture fish you purchased: what was the percentage imported from Vietnam or Thailand: _____% (97=DON'T KNOW)

306. How often do you pre-process your fish before re-selling (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |_____|, If Q306 is 1 NEVER or 97>>> MODULE I3 & If Q306 is 2 or 3 SOMETIMES OR ALWAYS >>307

307. What type of pre-processing do you do? (1= GUTTING; 2= REMOVING HEAD; 3= BOTH; 99 = OTHER SPECIFY): _____

308. In 2018, were you able to source enough aquaculture fish from Cambodian producers? (1= YES; 2= NO; 98= N/A) |_____|

309. What is your minimum threshold volume for one transaction to buy fish? _____Kg/transaction (97-DON'T KNOW; 98 N/A)

I3. PROCESSING ACTIVITY

If Q17 is 6 (Processor), then >> I3

If Q17 is 5 (Wholesaler), and Q20 =3 >> >> MODULE I3 , if Q20 = 1 >> MODULE J

If Q17 is 4 (Collector) >> Module J

NOTE: I am now going to ask you a number of questions about your fish processing activities in 2018 using AQUACULTURE FISH only. The following questions concern ONLY processing of fish from aquaculture (pond or cage).

NOTE: The following questions concern processing of fish from aquaculture during the year 2018 only

310: When did the peak season for aquaculture fish processing start in 2018? |_____| (MM) (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97-DON'T KNOW; 98= N/A)

311: When did the peak season for aquaculture fish processing end in 2018? |_____| (MM) (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97-DON'T KNOW; 98= N/A)

312: What was your maximum storage capacity in tons in 2018? |_____| tons

Rank the top two aquaculture fish processed products (in volume) for the processed fish market. Please also note the main species used.

313		314.1	315.1
Products	Code	RANK the most important (i.e. 1 st) product in terms of volume produced in 2018 (1= FIRST; 98= N/A)	Applies to which fish species – select the one main species per product in terms of volume (1 st product) (1 PANGASIUS; 2 WALKING CATFISH/CLARIAS; 3 TILAPIA; 4 CARP SPECIES; 5 SILVER BARB; 6 CHANNA STRIATA; 7 CHANNA MICROPELTES; 99 OTHER SPECIFY; 97 DON'T KNOW)
Salted/ dried	1		
Fillets	2		
Fermented Pangasius	3		
Smoked	4		
Fish paste/Prahoc	5		
Mam	6		
Other (specify)	99		

		314.2	315.2
Products	Code	RANK the second most important (i.e. 2 nd) product in terms of volume produced in 2018 (2= SECOND; 98= N/A)	Applies to which fish species – select the one main species per product in terms of volume (2 nd product) (1 PANGASIUS; 2 WALKING CATFISH/CLARIAS; 3 TILAPIA; 4 CARP SPECIES; 5 SILVER BARB; 6 CHANNA STRIATA; 7 CHANNA MICROPELTES; 99 OTHER SPECIFY; 97 DON'T KNOW)
Salted / dried	1		
Fillets	2		
Fermented Pangasius	3		
Smoked	4		
Fish paste/Prahoc	5		
Mam	6		
Other (specify)	99		

For the total volume of fish you processed:

317	318	319	320	321	322	323
What was the total quantity of fish (raw material) purchased in 2018?	Of this purchased fish, how much came from Cambodian Aquaculture in 2018	What was the total quantity of processed fish (final product) sold in 2018?	What was the average MINIMUM price sold per kg in 2018?	What was the average MAXIMUM price sold per kg in 2018	What was the total value of fish sold in 2018	Where is the main destination of the production (1: THIS VILLAGE; 2: THIS COMMUNE; 3: NEIGHBORING COMMUNE; 4: PHNOM PENH; 5: OTHER DISTRICT IN THE PROVINCE; 6: OTHER PROVINCE; 7: EXPORT; 97:DON'T KNOW)
Metric tons	Metric tons	Metric tons	KHR/KG	KHR/KG	KHR	
97:DON'T KNOW	97:DON'T KNOW	97:DON'T KNOW				

324: Of the total aquaculture fish you purchased for processing, what was the percentage of fish permanently lost between procurement and sale due to spoilage or similar? _____%

MODULE J: QUALITY POST HARVEST

If Q17 is 4 (Collector), 5 (Wholesaler); 6 (Processor), then Q325

If Q17 is ≠ >> MODULE K

NOTE: I am now going to ask you a number of questions about the quality of the fish and the criteria used to evaluate its quality. The following questions concern aquaculture FISH ONLY.

J1. QUALITY OF FISH PURCHASED

	326	327
	What are the quality criteria used when purchasing aquaculture fish? (MULTIPLE)	To what extent are those criteria met? If YES in Q326
	Code	(1: NEVER; 2: SOMETIMES; 3: AVERAGE; 4: OFTEN; 5:ALWAYS)
Minimum weight of the fish	1	
Homogeneous size of the fish	2	
Survival rate of live fish	3	
White flesh	4	
Absence of chemical use in pond	5	
Absence of trash fish use as feed	6	
No criteria	7	

328. Based on your experience or the above criteria, how would you rate the quality of the CAMBODIAN PRODUCED AQUACULTURE FISH you usually purchase? (1: VERY LOW; 2: LOW; 3: AVERAGE; 4: GOOD; 5: VERY GOOD; 97 DON'T KNOW):

J2. QUALITY OF RAW OR PROCESSED FISH – SELLING FISH

NOTE: For the main fish products you sell, what are the main quality criteria applied by the buyers and consumers?

329. What was the main raw and processed fish product you sold in 2018? (1= LIVE FISH; 2= CHILLED/DEAD FISH; 3= SALTED / DRIED; 4= SMOKED; 5= FISH PASTE; 6= MAM; 7= PRAHOC ; 8= FILLETS; 9= FERMENTED PANGASIUS; 99= OTHER SPECIFY):

If 329 is 1 or 2>>330

330: Is minimum size & minimum weight a criteria? (1=YES; 2= NO; 97= DON'T KNOW)

If 329 is 2>>332

332: Is freshness (Eyes – Gill color and form) a criteria? (1=YES; 2= NO; 97= DON'T KNOW)

If 329 is 3-9 or 99>> Q334

	335. What are the quality criteria for the product (MULTIPLE)
Characteristics of the processed product	Code
Absence of chemical use during processing	1
No bones	2
No scales	3
Khmer labelling	4
Individual package	5

K. KNOWLEDGE AND TRAINING

If Q17 is 1 (Hatcheries), 2 (Nurseries), 3(Producers), 4 (Collectors), 5 (Wholesalers), 6 (Processors); 9 (Feed distributors) >>Q336

If Q17 is # >> MODULE L

NOTE: I am now going to ask you a number of questions about the trainings you received in aquaculture and fish handling and processing. I will also ask you question about your different sources of information about aquaculture and fish handling and processing.

K1. TRAINING

336. When was your last training on aquaculture or fish marketing or processing? YEAR_____ (97 DON'T KNOW, 98 N/A) IF 98, >> Q338

337. What was the topic of the last training on aquaculture that you attended? (select only one answer): (1 POND MANAGEMENT; 2 FEED MANAGEMENT; 3: BUSINESS AND MARKETING; 4: HATCHERIES, NURSERIES TECHNIQUES, 5: PROCESSING, 6: HYGIENE AND STANDARD; 7: TRANSPORT AND STOCKING; 8: ACCESS TO FINANCIAL INSTITUTION; 97: DON'T KNOW; 99: OTHER (SPECIFY):
|_____|

338. Who delivered the training? (1= HARVEST, 2= FAIEX –JICA; 3=WORLDFISH; 4= HKI; 5= FIA; 6= PADEK; 7= CONSERVATION INTERNATIONAL; 8= IFAD; 97= DON'T KNOW; 99= OTHER SPECIFY) |_____| _____

339. In the past or currently, were you the beneficiary of any aquaculture project? (1=YES; 2= NO):_____ If NO in 339>>Q341

340. If so, in what year did/will the project end? _____

341. What was the name of the implementer/NAME of project? (1= HARVEST, 2= FAIEX –JICA; 3=WORLDFISH; 4= HKI; 97 DON'T KNOW; 99 OTHER SPECIFY) |_____| _____

K2: INFORMATION SOURCE

NOTE: I am now going to ask you a number of questions about your different sources of information related to aquaculture, fish trading and processing. This is about where you learn new techniques, where you access price and market information, and where you learn about new rules and regulations related to aquaculture fish trading and processing.

342		343	344	345
		Have you ever received information about the following?	Which is your MAIN source of information?	When did you most recently receive information
		1= YES	1.INPUT COMPANY OR RETAILER	1 EVERY DAY/ON-DEMAND
		2 = NO	2. HATCHERY AND NURSERIES	2 THIS WEEK
			3. FIA	3 THIS MONTH
		>> NEXT	4. NGOS/PROJECT	4 LAST 1-6 MONTHS
		ITEM	5. YOU TUBE	5 LAST 6-12 MONTHS
			6. FACEBOOK AND SOCIAL MEDIA	97 DON'T KNOW
			7. TV	
			8. RADIO	
			9. FISH BUYERS, WHOLESALERS, PROCESSORS	
			10. SMS SERVICE	
			11. DEMONSTRATION FARM	
			12. OTHER FARMER	
			99. OTHER SPECIFY	
	CODE			
Fingerling quality and prices	1			
Input availability and prices	2			
Fish farming techniques (feed, water management)	3			
Fish prices (live and dead on ice fish market)	4			
Processed fish prices	5			
Fish quality and standard	6			
Technical support (training)	7			

L. FINANCE

If Q17 is 1 (Hatcheries), 2 (Nurseries), 3 (Producers), 4 (Collectors), 5 (Wholesalers), 6 (Processors), 9 (Feed distributors) then >> Q346

If Q17 is # >> MODULE M

NOTE: I am now going to ask you a number of questions about loans and access to finance for investing in your aquaculture and fish trading and processing activities.

346. Did the Company or the farm receive any credit in the last 5 years to invest in aquaculture activities, wholesale or processing fish?

1=YES; 2= NO |_____| (if NO, >>Q347-Q355).

346.1. Did you or your company or your farm receive any credit in 2018 to invest in aquaculture activities, wholesale or processing fish?

1=YES; 2= NO |_____| (if NO, >>Q347-Q355).

NOTE: Please note that loans can be in cash or in-kind. Examples of in-kind loans are: feed, fingerlings or fuel.

347	348	349	350		351		352		353
Loan No	Source	Purpose of the loan	Amount		Interest rate		Duration of loan		How must this loan be repaid?
			Amount	Unit	%	Unit	Number	Unit	
	1 = MFI / BANK	1= BUYING FISH FEED	97: DON'T KNOW		97: DON'T KNOW		97: DON'T KNOW		1= IN CASH
	2 = HATCHERIES – NURSERIES	2= BUYING FISH SEED		1= KHR		1 = PER MONTH		1= MONTH	2= IN KIND
	3= FEED DEALER	3= BUYING LAND FOR POND, WAREHOUSE OR BUYING CAGE		2 = KG		2= PER YEAR		2= YEARS	3 = CASH & IN KIND
	4 = FISH COLLECTOR	4= REPAIRING POND/CAGE		3 = M TONS					
	5 = FISH PROCESSOR/WHOLESALE	5 = BUYING EQUIPMENT		4 = THOUSAND FINGERLINGS					
	6 = AGRICULTURAL INPUT SUPPLIERS	6 = RENTING LABOUR		99= OTHER (SPECIFY)					
	7= PRIVATE MONEYLENDER	7= BUYING VEHICLE (incl. boat)							
	8= RELATIVES/FRIENDS	8 = DIGGING A WELL							
	99 = OTHER (SPECIFY) _____	9= BUYING RAW MATERIAL FOR PROCESSING							
		99= OTHER AQUACULTURE-RELATED EXPENSE							
1									
2									
3									
4									
5									

354: Did you use the loans for the intended purpose, or was the loan invested somewhere else?

(1=YES; 2= NO; 97= DON'T KNOW):

355: Was the loan and investment worth the return? Please provide your perception on a scale of 5 (1= No, not all; 2= Not really; 3= break-even; 4= worth the investment; 5= really good return on investment; 97: DON'T KNOW): If YES to Q355>> MODULE M

If 355 is NO >>356

Q356: Why have you never taken a loan to support your activities? Is it because (tick the boxes- multiple choice question):

1: don't know how to take a loan; 1=YES; 2= NO ☐

2: don't know how to convince a banker; 1=YES; 2= NO ☐

3: afraid of loans; 1=YES; 2= NO ☐

4 too many loans contracted to support other activities; 1=YES; 2= NO ☐

5: No collateral; 1=YES; 2= NO ☐

6: Not sure I can re-pay the loan by investing in aquaculture, fish trade or fish processing;_1=YES; 2= NO ☐

7. Interest rates are too high; 1=YES; 2= NO ☐

99. Other (specify): _____

MODULE M: FEED MILLS

If Q17 is 7 (FEED MILL), >>Q357

NOTE: I am now going to ask you a number of questions about your feed manufacturing and aquaculture feed import activities. This is only for the year 2018, and only for activities in Cambodia.

357. Are you producing aquaculture feed in Cambodia? (1=YES; 2= NO) |_____| If NO to Q357 >>Q358-Q361

If YES in 357>>Q362

358. Do you plan to invest in an aquaculture feed mill in Cambodia in the next 5 years (1=YES; 2= NO; 3=MAYBE; 97= DON'T KNOW) |_____|

359. How high should be the demand for aquaculture feed in Cambodia (in thousand metric tons per year) to make you decide to invest in an aquaculture feed mill? _____Thousand metric tons per year? (97=DON'T KNOW; 98=N/A)

360. Did you import aquaculture feed to Cambodia in 2018? (1=YES; 2= NO) |_____| If NO>>363

If YES in Q360>> Q361

361. From where did you import this aquaculture feed in 2018? (1=VIETNAM; 2=THAILAND; 3=OTHER (specify)) |_____|

362. How many aquaculture feed mills did you operate in 2018? |_____| (number)

363. Are you producing poultry or pig feed in Cambodia? (1=YES; 2= NO) |_____| If NO>>Q365

If YES in Q363>> Q364

364. How many poultry and pig feed mills did you operate in 2018? |_____|

M1: IMPROVED MANAGEMENT PRACTICES

IF YES in Q357 or YES in Q360 >>Q365

If NO in Q357 AND NO in Q360 >>MODULE M5

NOTE: I am now going to ask you a number of questions about your marketing, distribution and labelling of aquaculture feed. This is only for the year 2018, and only for activities in Cambodia.

M1.1.Marketing and distribution

365. Can your customers place orders online (WebApp)? (1=YES; 2= NO) |_____|

M2.2.Value-added processing

- 366. Are the feed bags and instructions on the feed bag labelled in Khmer language (1=YES; 2= NO; 97= DON'T KNOW) |_____|
- 367. Do the feed bags indicate the manufacturing date (1=YES; 2= NO; 97= DON'T KNOW) |_____|
- 368. Do you indicate on the bag the recommended ration or feeding guide in percentage of fish biomass (fish weigh) (i.e. if fish is 100 g – the daily amount of feed per day is Z% of the fish weight) (1=YES; 2= NO; 97= DON'T KNOW) |_____|

M2.3. Other

- 369. Do you implement pest controls in the manufacture and storage places of the raw and finished products (1=YES; 2= NO; 97= DON'T KNOW) |_____|

M2. AQUAFEED QUALITY

IF YES in Q357 or YES in Q360 >>Q371

If NO in Q357 AND NO in Q360 >>MODULE M5

NOTE: I am now going to ask you a number of questions about the characteristics of your aquaculture feed.

		370	371	372	373	374	375
		Do you sell pellets for [species]?	Type	How many different sizes of pellets for the same species	Max crude protein content	Lowest crude protein	Moisture content
	CODE	1= YES 2= NO >> NEXT	1 FLOATING 2 SINKING 97 DON'T KNOW	Number (max 8)	% 97 DON'T KNOW	% 97 DON'T KNOW	% 97 DON'T KNOW
Tilapia	1						
Pangasius	2						
Snakehead	3						
Walking catfish	4						
Carp	5						

376. In 2018, what was your major source of soymeal in volume? (1: USA; 2: ARGENTINA; 3: BRAZIL; 97 DON'T KNOW; 98 N/A; 99: OTHER (SPECIFY)): |_____| _____

377. In 2018, what was your major source of fishmeal in volume? (1: PERU; 2: THAILAND; 3 SPAIN; 97 DON'T KNOW; 98 N/A; 99: OTHER (SPECIFY)): |_____| _____

M3. INTERNATIONAL Standards

IF YES in Q357 or YES in Q360 >>Q378

If NO in Q357 AND NO in Q360 >>MODULE M5

NOTE: I am now going to ask you a number of questions about international standards followed by your company when producing aquaculture feed.

378. Is the aquaculture feed you import or produce compliant and certified with any of the following standards (tick the box – multiple choices)

1. ISO 9001: Quality management: 1=YES; 2= NO ☐
2. ISO 14001: Environment System Certification: 1=YES; 2= NO ☐
3. ISO 22000: Food safety management: 1=YES; 2= NO ☐
4. HACCP Hazard Analysis and Critical Control Points: 1=YES; 2= NO ☐
5. Best Aquaculture Practices: 1=YES; 2= NO ☐
6. Global G.A.P. standard 1=YES; 2= NO ☐
7. None

M4. VOLUME AND VALUE OF SALES OF FIRM

IF YES in Q357 or YES in Q360 >>Q380

If NO in Q357 AND NO in Q360 >>MODULE M5

NOTE: I am now going to ask you a number of questions about your aquaculture feed trade and sales in 2018.

380	381	382	383
What was the total quantity of produced or imported aquafeed in 2018?	What was total quantity sold in 2018?	What was the average price sold per metric ton in 2018?	Total value of sales
Metric tons 97 DON'T KNOW	Metric tons 97 DON'T KNOW	KHR/ M tons 97 DON'T KNOW	Million KHR

M5. MARKET INFORMATION

NOTE: I am now going to ask you a number of questions about how you market animal feed (including aquafeed).

384. How do you inform your customers about animal feed (including aquafeed) price information?

Rank the two main communication channels that you use to inform customers about animal feed price. What are the most- and second most-important communication channels?

385.1	385.2
What is the 1st main communication channel?	What is the 2nd main communication channel?
1.DISTRIBUTORS AT PROVINCE-DISTRICT LEVEL	1.DISTRIBUTORS AT PROVINCE-DISTRICT LEVEL
2. HATCHERY AND NURSERIES	2. HATCHERY AND NURSERIES
6. FACEBOOK AND SOCIAL MEDIA	6. FACEBOOK AND SOCIAL MEDIA
7. TV	7. TV
8. RADIO	8. RADIO
9. FISH BUYER, WHOLESALER	9. FISH BUYER, WHOLESALER
11. SMS SERVICE	11. SMS SERVICE
12. DEMONSTRATION FARM/FAIR	12. DEMONSTRATION FARM/FAIR
97: DON'T KNOW	97: DON'T KNOW
98: N/A	98: N/A
99: OTHER SPECIFY	99: OTHER SPECIFY

385.1: 1st Communication channel: _____

385.2: 2nd Communication channel: _____

M6. BUSINESS PLAN

IF YES in Q357 or YES in Q360 >>Q386

If NO in Q357 AND NO in Q360 >> MODULE M7

NOTE: I am now going to ask you a number of questions about business management practices, and about how you plan your investment. We would also like to know your opinion about the demand for aquaculture feed in Cambodia.

Note: Questions below concern ONLY AQUAFEED

386. What is your estimation of the local demand for aqua-feed by volume at the country level (Cambodia) in 2018? (97= DON'T KNOW)
|_____| Thousand metric tons/ year

387. To be competitive in Cambodian markets, how much do you estimate should be the production cost of 1 kg of feed for pangasius?
(97= DON'T KNOW) |_____| KHR/kg

388. How many retailers/distributors in Cambodia did you work with to sell aquaculture feed in 2018? (97= DON'T KNOW) |_____|

389. How many farmers & hatcheries in Cambodia did you work with directly in 2018? (97= DON'T KNOW) |_____|

390. In 2018, how many WRITTEN contracts/ agreements with retailers/distributors and farmers were you able to fill? (97= DON'T KNOW)
|_____|

391. In 2018, how many ORAL contracts/ agreements with retailers/distributors and farmers were you able to fill? (97= DON'T KNOW) |_____|

392. Do you provide loans in-kind (feed) to retailers/distributors or farmers? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |_____|

393. Do you provide technical assistance to fish farmers, with your technician directly going to the farm? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) |_____| If ALWAYS/SOMETIMES in Q393>>>Q395-Q396 & If NEVER in Q393>>>Q394

394. Are you interested to do so in the future? (1=YES; 2= NO; 97= DON'T KNOW) |_____|

395. How many technicians did you have with the ability to provide support to farmers in 2018? (97= DON'T KNOW) |_____| number of technicians

396. How many farmers were supported by those technicians in 2018? (97= DON'T KNOW) |_____| number of farmers supported

M7. FINANCE

397. Have you contracted or do you currently contract loans to produce feed (aquaculture, pig, poultry) in Cambodia? (1=YES; 2= NO; 97= DON'T KNOW) |_____|

If NO or Don't Know >> End of Survey

If YES in 397>>Q398

398. Is it a loan from? (1= BANKING INSTITUTION; 2= NON-BANKING INSTITUTION; 3 BOTH) |_____|

END OF SURVEY FOR FEED MILLS

MODULE N: MICRO-FINANCE AND FINANCE INSTITUTIONS

If Q17 is 8 (Micro-Finance and Banking), then Q399

NOTE: I am now going to ask you a number of questions about loan and banking activities that support aquaculture in Cambodia.

NOTE: These questions are related to the activities of your organization/bank at the provincial level in 2018

	400		401	402_min	402_max	403	404	405	406	407
Aquaculture activities	Code	Have you disbursed loans to support aquaculture activities in 2018?	How many loans were distributed that supported Cambodian aquaculture?	What is the minimum amount? KHR/ loan	What is the maximum amount? KHR/ loan	What is the average amount? KHR/ loan	What is average interest rate?	Unit of interest rate	What is the average duration of those loans? (month)	Of the disbursed loans, what is the percentage of loans re-paid on time?
		1= YES 2= NO 2 >>NEXT Line	NUMBER 97: DON'T KNOW	KHR 97: DON'T KNOW	KHR 97: DON'T KNOW	KHR 97: DON'T KNOW	% 97: DON'T KNOW	1. PER MONTH 2. PER YEAR	Month 97: DON'T KNOW	% 97: DON'T KNOW
Fish farmers	1									
Hatcheries and nurseries	2									
Fish buyers and wholesalers	3									
Fish processors	4									
Feed distributors	5									

408: What is the main limitation for you to disburse loans to hatcheries/nurseries? (1 HIGH RISK OF NO REPAYMENT: NOT PROFITABLE ENOUGH; 2 LIMITED COLLATERAL; 3 AGAINST INTERNAL POLICY (NO LOAN TO HATCHERIES/NURSERIES); 4 NO DEMAND; 97: DON'T KNOW; 99 OTHERS – SPECIFY) | _____|

409: What is the main limitation for you to disburse loans to **fish farmers**? (1 HIGH RISK OF NO REPAYMENT: NOT PROFITABLE ENOUGH; 2 LIMITED COLLATERAL; 3 AGAINST INTERNAL POLICY (NO LOAN TO FISH FARMER); 4 NO DEMAND; 97: DON'T KNOW; 99 OTHERS (SPECIFY)) |_____| _____

410: What is the main limitation for you to disburse loans to wholesalers/collectors? (1 HIGH RISK OF NO REPAYMENT: NOT PROFITABLE ENOUGH; 2 LIMITED COLLATERAL; 3 AGAINST INTERNAL POLICY (NO LOAN TO FISH WHOLESALERS/COLLECTORS); 4 NO DEMAND; 97: DON'T KNOW; 99 OTHERS (SPECIFY)) |_____| _____

411: What is the main limitation for you to disburse loans to fish **processors**? (1 HIGH RISK OF NO REPAYMENT: NOT PROFITABLE ENOUGH; 2 LIMITED COLLATERAL; 3 AGAINST INTERNAL POLICY (NO LOAN TO FISH PROCESSORS); 4 NO DEMAND; 97: DON'T KNOW; 99 OTHERS (SPECIFY)) |_____| _____

412: What is the main limitation for you to disburse loans to aquafeed distributors? (1 HIGH RISK OF NO REPAYMENT: NOT PROFITABLE ENOUGH; 2 LIMITED COLLATERAL; 3 AGAINST INTERNAL POLICY (NO LOAN TO AQUAFEED DISTRIBUTOR); 4 NO DEMAND; 97: DON'T KNOW; 99 OTHERS(SPECIFY)) |_____| _____

END OF SURVEY MICRO _FINANCE AND FINANCE INSTITUTIONS

MODULE O: FEED DISTRIBUTORS

If Q17 is 9 (Feed distributors), then >>Q413

NOTE: I am now going to ask you a number of questions about your aquaculture feed retailing activities.

MODULE O.1. Type of aquaculture feed

NOTE: I am now going to ask you a number of questions about the product you sell. We will focus in particular on aquaculture feed.

413. Are you selling the following products (tick the boxes; multiple choices are possible):

	Code
Feed for pigs	1
Medicine for pigs	2
Feed for chicken	3
Medicine for chicken	4
Feed for fish	5
Antibiotics for fish	6
Pro-biotics and additives for fish feed	7
Fertilizer such DAP (Di amino Phosphate) or Triple Super Phosphate (TSP)	8
Agricultural lime (Ca Co ₃) or Dolomite	9
Burned lime (CaCo)	10

NOTE: I am now going to ask you a number of questions about the aquaculture feed you sell.

414. When did you start selling aquaculture feed? |____| (YYYY)_YEARS

415. How many brands of aquaculture feed are you selling? |____|

416. What are the brands (tick the boxes; multiple choice possible)

1. Ocialis 1=YES; 2= NO |____|
2. CP 1=YES; 2= NO |____|
3. Ly Hong Choy 1=YES; 2= NO |____|
4. Agri-Master 1=YES; 2= NO |____|
5. Dollar 1=YES; 2= NO |____|
6. Green Feed 1=YES; 2= NO |____|
7. Doctor Nupak 1=YES; 2= NO |____|
8. Other (specify):_____

Can you tell us more about the aquaculture feed you are selling? For each type of aquaculture feed, can you tell us:

417		418	419	420	421	422	423	424
Do you sell feeds for [species]?	CODE	Type	How many different sizes of pellets for the same species	Max crude protein content	Lowest crude protein	Moisture content	Most preferred brand for each species	Main reason of success and preference of farmers for this brand
1= YES 2= NO >> NEXT			Number	%	%	%		
		1 FLOATING		97 DON'T KNOW	97 DON'T KNOW	97 DON'T KNOW	1. OCIALIS	1. AVAILABILITY
		2 SINKING	97 DON'T KNOW	98 N/A	98 N/A	98 N/A	2. CP	2. QUALITY
		97 DON'T KNOW					3. LY HONG CHOY	3. COMPETITIVE PRICE
		98: N/A					4. AGRIMASTER	4. IN KIND LOANS
							5. DOLLAR	99. OTHER (SPECIFY)
							6. GREEN FEED	
							7. Doctor Nupak	
							99. OTHER (SPECIFY)	
Tilapia	1							
Pangasius	2							
Snakehead	3							
Walking catfish/clarias	4							
Carps	5							

425.1. Can you rank the best/highest selling in terms of volume of feed? Is it feed for: 1: TILAPIA FEED; 2. PANGASIUS FEED; 3. SNAKEHEAD FEED; 4. CLARIAS- CATFISH FEED; 5. CARP FEED; 98. N/A; 99. OTHER SPECIFY _____): _____

425.2. Can you rank the 2nd best/highest selling in terms of volume of feed? Is it feed for: 1: TILAPIA FEED; 2. PANGASIUS FEED; 3. SNAKEHEAD FEED; 4. CLARIAS- CATFISH FEED; 5. CARP FEED; 98. N/A; 99. OTHER SPECIFY _____): _____

425.3. Can you rank the 3rd best/highest selling in terms of volume of feed? Is it feed for: 1: TILAPIA FEED; 2. PANGASIUS FEED; 3. SNAKEHEAD FEED; 4. CLARIAS- CATFISH FEED; 5. CARP FEED; 98. N/A; 99. OTHER SPECIFY _____): _____

MODULE O2. Seasonality and volume

NOTE: I am now going to ask you a number of questions about your trade and sales of aquaculture feed in 2018.

426. In which month did the peak season for selling aquaculture feed start in 2018? (MM) (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97-DON'T KNOW; 98= N/A)

427. When did the peak season for selling aquaculture feed end in 2018? (MM) (1 JANUARY; 2 FEBRUARY; 3 MARCH; 4 APRIL; 5 MAY; 6 JUNE; 7 JULY; 8 AUGUST; 9 SEPTEMBER; 10 OCTOBER; 11 NOVEMBER; 12 DECEMBER; 97-DON'T KNOW; 98= N/A)

428. What was the total quantity of aquaculture feed sold during the peak season in 2018? (tons) _tons 97-DON'T KNOW

429. What was the total quantity of aquaculture-feed sold during the low season in 2018? (tons) _tons 97-DON'T KNOW

430. Compared to 2015, how was the volume of sales of aquaculture in 2018 (1= MUCH HIGHER, MORE THAN DOUBLE; 2= HIGHER: BETWEEN 1.5 TIMES TO DOUBLE; 3= SIMILAR VOLUME; 4= LOWER: IT DECREASED TO HALF THE VOLUME; 5= SIGNIFICANTLY LOWER WITH LESS THAN HALF; 97: DON'T KNOW):

431. How do you explain this trend? (Multiple choice):

1. More farmers 1=YES; 2= NO
2. Less farmers 1=YES; 2= NO
3. Farmers are using more feed now 1=YES; 2= NO
4. Farmer are using less feed 1=YES; 2= NO
5. Feed is more available than before 1=YES; 2= NO
6. Feed is less available than before 1=YES; 2= NO
7. More feed sellers going to the farm directly 1=YES; 2= NO
8. Less feed sellers going to the farm directly 1=YES; 2= NO
9. Price of feed is cheaper 1=YES; 2= NO
10. Price of feed is higher 1=YES; 2= NO
11. Don't know – cannot explain 1=YES; 2= NO

432. What was the average selling price of aquaculture feed pellets in KHR per kilogram in 2018? _ _ KHR/kg (97= DON'T KNOW)

433. What was the highest price of aquaculture feed in KHR per kilogram in 2018? _ _ KHR/kg (97= DON'T KNOW)

434. What was the lowest price of aquaculture feed in KHR per kilogram in 2018? _ _ KHR/kg (97= DON'T KNOW)

435. What was the total value of aquaculture feed sales in 2018 (KHR)? _ _ KHR (97= DON'T KNOW)

MODULE O3: Quality and standards

NOTE: I am now going to ask you a number of questions about the international standards of the feed you sell

436. Is at least one of the brands of aquaculture feed you sell compliant and certified with any of the following standards? (tick the box – multiple choice)

1. ISO 9001: Quality management: 1=YES; 2= NO; 97= DON'T KNOW
2. ISO 14001: Environment System Certification: 1=YES; 2= NO; 97= DON'T KNOW
3. ISO 22000 Food safety management: 1=YES; 2= NO; 97= DON'T KNOW
4. HACCP Hazard Analysis and Critical Control Points: 1=YES; 2= NO; 97= DON'T KNOW
5. Best Aquaculture Practices: 1=YES; 2= NO; 97= DON'T KNOW
6. Global G.A.P. standard: 1=YES; 2= NO; 97= DON'T KNOW
7. None

437. Are the feed bags stored on the floor directly (1=YES; 2= NO; 97= DON'T KNOW)

438. Are the feed bags in contact with the wall (1=YES; 2= NO; 97= DON'T KNOW)

439. How often do you check the manufacturing date of the aquaculture feed you sell? (1=NEVER; 2= SOMETIMES; 3= ALWAYS)

MODULE O4: Market information and knowledge sharing

NOTE: I am now going to ask you a number of questions about your knowledge of aquaculture. I will also ask about how you share this knowledge with the fish farmers purchasing feed in your shop.

440. Did you have technician(s) to support the farmers in 2018? (1=YES; 2= NO) If NO>>> Q443

If YES >> Q441

441. How many technicians were working with you in 2018? Number of technicians

442. In total, how many farmers were supported by those technicians in 2018? (97-DON'T KNOW) Number of farmers

443. Did you yourself provide technical support to farmers in 2018? (1=YES; 2= NO) if NO>> Q448

If YES to 443 >>Q444

444. Did you provide technical advice at the shop in 2018? (1=YES; 2= NO)

445. Did you provide technical advice at the farm in 2018? (1=YES; 2= NO) if NO in Q445>> Q448

If YES to 445 >>Q446

446. How many farmers did you support at the farm directly in 2018? Number of farmers

If YES in Q440 or YES in Q443 >> Q447

IF NO in Q440 or YES in Q443>>Q448

447. If you or technician(s) are providing technical support, from whom did you acquire the knowledge? (multiple choice)

1. Feed company training 1=YES; 2= NO
2. FiA training 1=YES; 2= NO
3. NGO or project training 1=YES; 2= NO
4. Learning by yourself (through experience) 1=YES; 2= NO
5. Media (internet, radio, TV) 1=YES; 2= NO
99. Other specify _____

448. (If NO in Q440 & Q443) Are you interested to do so in the future? (1=YES; 2= NO; 97= DON'T KNOW)

449. When was your last training on aquaculture techniques? YEAR_____ (97 DON'T KNOW, 98 N/A)

450. Who delivered the training? (1= HARVEST, 2= FAIEX –JICA; 3=WORLDFISH; 4= HKI; 5= FIA; 6: PADEK; 7: CONSERVATION INTERNATIONAL; 8: IFAD; 97 DON'T KNOW 99: OTHER SPECIFY)

451. Do you know how to use a feed table to know how much feed per day the farmer should give to the fish? (1=YES; 2= NO; 97= DON'T KNOW)

452. Do you provide feed tables to the farmers? (1=YES; 2= NO; 97= DON'T KNOW)

453. How many different pellet sizes are you recommending farmers to use during one production cycle? _____ number of pellet sizes (Rules between 1 and 8) (97= DON'T KNOW)

Module O5. Business management

NOTE: I am now going to ask you a number of questions about the way you manage your shop. I will also ask you about the types of contracts you have with aquaculture feed buyers and feed companies.

455. How often do you record the volumes and costs of your inputs in a log book? (1=NEVER; 2=SOMETIMES; 3=ALWAYS; 97= DON'T KNOW)

456. How often do you record your sales? (1=NEVER; 2=SOMETIMES; 3=ALWAYS; 97= DON'T KNOW)

NOTE: I am now going to ask you a number of questions about the way you manage your shop, and about the types of contracts you have with aquaculture feed buyers.

457. What type of contract/agreement do you have with fish farmers: 1 WRITTEN; 2 ORAL; 3 NO CONTRACT

458. What type of contract/agreement do you have with smaller distributors: 1 WRITTEN; 2 ORAL; 3 NO CONTRACT IF 3 in Q457 and Q458 >> Q461

IF 1 or 2 in in Q457 or Q458 >> Q459

459. How many contracts/agreements were you able to fill in 2018? _____ (97: DON'T KNOW)

460. What is the average volume of each contract/agreement in 2018? _____ Kg

461. How often do you give a cash advance or in kind (feed) at the beginning of the cycle preceding the sales? (1=NEVER; 2=SOMETIMES; 3=ALWAYS; 97= DON'T KNOW) _____ IF NEVER or 97 in Q461 >> Q467

If SOMETIMES/ALWAYS in Q461>>>Q462

462. How frequently is the loan repaid in full at harvest? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) _____

463. How frequently is the loan repaid in installments? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) _____

464. What is the difference in the price of 1 kg of feed when paying cash versus asking for a loan in kind? : _____ KHR/kg

465. When contracting a loan in kind, do the fish farmers need to sell the harvest to you or the feed company? (1= NEVER; 2= SOMETIMES; 3= ALWAYS) _____

466. In 2018, what percent of your total sales (in volume) of aquaculture feed is subject to in-kind loans? _____% (97= DON'T KNOW; 98 =N/A)

NOTE: I am now going to ask you a number of questions about the way you manage your shop, and about the types of contracts you have with feed mills and feed companies

467. How many firms (feed brands) were you in contract with in 2018? number of firms

468. Are the contracts exclusive with a single firm? (1=YES; 2= NO; 98 N/A)

469. What type of contract/agreement do you have with feed firms? (1 WRITTEN; 2 ORAL; 3 NO CONTRACT) if 3 NO
>>>Q474

470. What is the average volume of each contract/agreement per year? (Unit: Tons of aquaculture feed per year; 97= DON'T KNOW; 98=N/A)

471. Does the contract/agreement stipulate a minimum volume of aquaculture feed to sell? (1=YES; 2= NO; 98= N/A) IF 2 or 98 in Q471 >> Q474

If YES 1 in Q471>>>Q472

472. What was the minimum sales target per month during the peak sales period in 2018? tons per month (97: DON'T KNOW)

473. Did you face any issues to achieving the minimum sales target in the peak period in 2018? (1=YES; 2= NO; 98= N/A)

474. Does the company give you the feed in advance, and you pay the company back, depending on your sales? (1=YES; 2= NO)

476. How often does the company provide technical support to you and your customers? (1= NEVER; 2= SOMETIMES; 3= ALWAYS)

477. Do you know in advance how much fish feed you need for the month to come? (1=YES; 2= NO)

478. Do you know in advance the cash return of your activity for the month to come? (1= NEVER; 2= SOMETIMES; 3= ALWAYS)

END OF SURVEY

Key Informant Questionnaires

Introduction to use before starting the Interview

Hello, everyone. My name is <state name> and I work with WorldFish. We have been contracted by the American Soybean Association's (ASA) World Initiative for Soy in Human Health (WISHH) program to conduct research into the Cambodian aquaculture sector for a newly funded project called Commercialization of Aquaculture for Sustainable Trade – Cambodia, or CAST. CAST is a 5-year project funded by the United States Department of Agriculture (USDA) that will provide targeted support to the commercial aquaculture development sector in Cambodia. The project plans to build the industry by linking different actors within the value chain while also improving the technical and managerial practices of numerous value chain actors.

The information we gather from you today will help CAST to better understand the barriers and facilitators to producing and selling fish in Cambodia. Your feedback will help project leadership to adjust programming to meet the needs of the sector and adjust to realities on the ground. We value your perspective and are thankful for your willingness to speak with us about these important topics.

Before we begin I would like to go over a few basic ground rules for our discussion.

- This session is being audiotaped to help with note taking. Please speak in a voice as loud as mine, so that the microphone can pick up what you are saying.
- Your answers will be kept confidential. Your name will not be connected to any of your responses and the information collected will only be used for the purposes of this study.
- You may decline to answer any question or end our conversation at any time.

Do you have any questions before we get started?

CAST PARTNERS, DEVELOPMENT PARTNERS, UNIVERSITIES AND GOVERNMENT

Topic 1. Aquaculture Industry

Constraints and opportunities to develop commercial aquaculture in Cambodia

Let's talk about your vision of the aquaculture sector in Cambodia and what you believe are the constraints and opportunities for developing the commercial aquaculture in this country. Based on your understanding of the sector and past experiences:

1. What changes should be made the aquaculture system in Cambodia to increase the profitability of producers and hatcheries?
 - o Prompt for⁵⁹: technical improvement; market access; introduction of high quality genetic strains.
2. Please share your thoughts about the current level of communication and information sharing between actors within the Cambodian value chain. Provide 1-2 examples.
 - o Prompt for: information and communication regarding price, quality requirements, and access to new technologies (or lack thereof)
 - o What should be done to improve communication and information sharing within the Cambodian aquaculture industry?
3. *What do you think about the quality of fingerlings and aquaculture feed currently available in Cambodia?*
 - o *What needs to happen to increase access to these commodities?*
4. What do you think about the performance of the extension service and private support systems in the Cambodian aquaculture sector?
 - o What steps should be taken improve the performance of these services and/or systems?
5. What, if anything, should to be done to help producers, hatcheries but also processors and post-harvest actors access financial services in Cambodia?
6. *What opportunities currently exist for improvements in the production, transport, and processing of fish within the aquaculture value chain?*
 - o *What is needed to improve the performance of fish processing and/or the post-harvest storage and handling of Cambodian-sourced fish?*
 - *Prompt for: issues related to certain forms of processing (e.g., fermented, smoked, dried, filleted, skinned) and storage capacity and quality control*
7. From your point of view, what are the aquaculture processed products that have the highest potential for growth in Cambodia? Please explain.

Constraints and opportunities to develop a traceability and quality control system, such as sanitary and phytosanitary standards (SPS), for aquaculture products.

Let's talk about SPS and quality control system and what you believe are the constraints and opportunities to develop and enforce a quality control and traceability system in the aquaculture sector. Based on your understanding of the sector and past experiences:

8. *What regulations should be put in place to ensure that quality inputs are available throughout the aquaculture value chain?*
 - o Prompt for: feed produced in Cambodia or imported and/or quality control/biosecurity measures
9. What should be done to improve the regulation of quality standards for aquaculture products with the aquaculture value chain?

⁵⁹ Prompts should only be used if the respondent has a hard time articulating what, in the case, should be done to improve the profitability of the aquaculture system

- o Prompt for: standards for the different processed products and fish on ice or frozen
 - o Based on your experience with other sectors (e.g., vegetables), what, if any, additional regulations should be developed for the aquaculture industry in Cambodia?
10. *We are also interested in your opinion about current regulations about farm management practices throughout the aquaculture value chain.*
- o *What is the current status of regulations about farm management practices and what, if anything, do you think should be improved?*
 - *Prompt for: the use of chemicals and/or antibiotics and the release of water into the environment*
11. What do you think are the main constraints to developing a traceability system for aquaculture products in Cambodia?
12. What do you think are the main opportunities to developing a traceability system for aquaculture products in Cambodia (e.g., species, consumer group target, existing experiences)?
- Which existing value chain actors should we involve in the conversation about developing a traceability system for this purpose?
 - What new or addition value chain actors should we involve in this discussion?

Topic 2: Project implementation

Let's talk now about CAST project and other project in the aquaculture sector.

Support services needed & awareness

13. What are other initiatives or development projects that are currently supporting the aquaculture industry in Cambodia?
- o What do you think CAST should do to create positive synergy with these other projects?
 - o What, if any, additional services or activities do you think would be of value to the different beneficiaries of the project?

PROJECT BENEFICIARIES

1. HATCHERIES & NURSERIES

Topic 2. Program Implementation

Let's talk about the CAST project and what you believe are the barriers and facilitators to implementing the project. Based on your understanding of the sector and past experiences:

Barrier and facilitators to program implementation

1. What are the main barriers to increasing the quantity and improving the quality of fingerlings produced on your farm each year?
 - Prompt for: at least 1-2 barriers to increasing the quantity of fingerlings and 1-2 barriers to improving the quality of fingerlings
2. What are the main barriers that you face when trying to market your fingerlings?
 - Prompt for: access to marketing information, access to customer, transportation capacity, competitive price
3. *What, if any, recommendations do you have for potential solutions to these barriers?*
 - o *Prompt for: capacity building (e.g. training), coordination with other actors of the value chain (e.g., communication and exchange), infrastructure (e.g., access to road, electricity), and investment capacity (e.g., access to loan and financial mechanism)*
 - o *Why do you think these barriers have not been addressed in the past?*
4. *What, if any, facilitators currently exist that could help you to produce and market your fingerlings?*
 - *Prompt for: access to quality seed/clean water, help from neighbors or family members, returning customers/word of mouth, proximity to road/transportation*
5. [Question for hatcheries only] Would it be possible for you to become a hatchery that only sells directly to nurseries?
 - If YES, what would you do to accomplish this? [collect information about facilitators]
 - If NO, what would prohibit you from doing so? [collect information about barriers]
6. [Question for hatcheries only] We are interested in learning more about a) your interest in transforming your hatchery into a nursery and b) what you would need to do to make this transformation possible.
 - On a scale of 1-10, how interested are you in operating as a nursery only?
 - What, if any, facilitators currently exist that could help you transform your nursery into a hatchery?
 - What, if any, barriers would you likely encounter if you tried to transform your hatchery into a nursery?

Assumption: a number of hatcheries will have some ponds reserved for fingerlings that they do not sell, so they will already be operating in some capacity as nurseries

Support services needed & awareness

Let's talk about the CAST project and what type of service and support the project can provide.

7. Do you currently receive or have you in the past received support services from any other aquaculture projects?
 - a. If YES, please describe the type of services you received and the duration for which you received these services (e.g., one day, two months, three years)
 - i. What kind of support services have you found most and least useful for your business?
 - b. If NO, please describe the type of services that you think would most benefit your business (e.g.,

technical training, access to quality inputs and genetic material such as brood fish; connection with customers, access to market information).

i. What, if any, barriers do you think have prevented you from receiving these services from other aquaculture projects?

8. [Question for hatcheries only] What support services do you think CAST should provide to hatcheries operating in Cambodia? Please explain. [Respondent should answer this question first before interviewer asks the following three questions about additional support]
 - a) What, if any, additional support is needed to improve the quality of your seed?
 - b) What, if any, additional support is needed to increase volume of production?
 - c) What, if any, additional support is needed to improve marketing and access to market?
9. [Question for nurseries only] What support services do you think CAST should provide to nurseries operating in Cambodia? Please explain. [Respondent should answer this question first before interviewer asks the following three questions about additional support]
 - a) What, if any, additional support is needed to improve the quality of fingerlings?
 - b) What, if any, additional support is needed to increase volume of production?
 - c) What, if any, additional support is needed to improve marketing and access to market?
10. [Question for nurseries only] What support services do you think CAST should offer to Cambodian feed mills and hatcheries to help improve the quality of their feed and seed?
 - a. How do you think that these interventions would increase the quantity and improve the quality of fingerlings produced on your farm?

Topic 3. Relationship building

Let's talk about access to knowledge and how you interact with other actors of the aquaculture sector.

11. How and from where do you get information about the market for fingerlings in Cambodia?
 - Do you currently have enough information about the market for Cambodian fingerlings?
 - o If YES, what has enabled you to have this information? [collect information about opportunities]
 - o If NO, what has prohibited you from accessing this information? [collect information about constraints]
12. What steps do you think should be taken to ensure that hatcheries and nurseries have up-to-date information about the current market for fingerlings in Cambodia?
13. Please describe your current relationship with your customers. [Provide the respondent with 1-2 minutes to describe their consumer base and current relationships with their customers]
 - o Would you say that you have a good working relationship with individual consumers and local businesses?
 - If YES, why? [collect information about opportunities]
 - If NO, why not? [collect information about constraints]
 - o In what areas do you think that your relationship with individual consumers and businesses could be improved?
14. *Do you have strong relationships with other hatcheries and nurseries in Cambodia?*
 - o *If YES, who do you have these relationships with and what has helped you to build these relationships? [collect information about opportunities]*
 - o *If NO, what has prohibited you from forming strong relationships with other hatcheries and nurseries? [collect information about constraints]*
15. *What, if anything, do you think could be done to improve your relationship with other hatcheries and nurseries?*
16. *Would you join and participate in an Aquaculture Association or a similar social network to improve*

linkages and collaboration between value chain actors?

- o If YES, why? [collect information about opportunities]*
- o If NO, why not? [collect information about constraints]*

17. From your point of view, what should be the overall goal(s) of this Association?

1. PRODUCERS

Topic 2. Program Implementation

Let's talk about the CAST project and what you believe are the barriers and facilitators to implementing the project. Based on your understanding of the sector and past experiences:

Barrier and facilitators to program implementation

1. What are the main barriers to increasing the quantity and improving the quality of fish produced on your farm each year?
 - Prompt for: at least 1-2 barriers to increasing the quantity of fish and 1-2 barriers for improving the quality of fish
2. What are the main barriers that you face when trying to market your fish?
 - Prompt for: access to marketing information, access to customers, transportation capacity, competitive prices.
3. *What, if any, recommendations do you have for potential solutions to these barriers?*
 - o *Prompt for: capacity building (e.g. training), coordination with other actors of the value chain (e.g., communication and exchange), infrastructure (e.g., access to road, electricity), and investment capacity (e.g., access to loan and financial mechanism)*
 - o *Why do you think these barriers have not been addressed in the past?*
4. What, if any, facilitators currently exist that help you to produce and market your fish?
 - Prompt for: access to quality fingerlings/clean water, help from neighbors or family members, returning customers/word of mouth, proximity to road/transportation

Support services needed & awareness

Let's talk about the CAST project and what type of service and support the project can provide.

5. Do you currently receive or have you in the past received support services from any other aquaculture projects?
 - a. If YES, please describe the type of services you received and the duration for which you received these services (e.g., one day, two months, three years)
 - i. What kind of support services have you found most and least useful for your business?
 - b. *If NO, please describe the type of services that you think would most benefit your business (e.g., access to market information; technical training on feeding, pond preparation, business management training).*
 - ii. *What, if any, barriers do you think have prevented you from receiving these services from other aquaculture projects?*
6. What support services do you think CAST should offer to aquaculture producers operating in Cambodia? Please explain. [Respondent should answer this question first before interviewer asks the following three questions about additional support]
 - a) What, if any, additional support is needed to improve the quality of fish?
 - b) What, if any, additional support is needed to increase volume of production?
 - c) What, if any, additional support is needed to improve marketing and access to market?
7. *What support services do think CAST should offer to Cambodian hatcheries and nurseries to help improve the quality of their products?*
 - *How do you think that these interventions would increase the quantity and improve the quality of fish produced from your farm?*

Topic 3. Relationship building

Let's talk about access to knowledge and how you interact with other actors of the aquaculture sector.

8. How and from where do you get information about the market for fish in Cambodia?

- Do you currently have enough information about the market for Cambodian fish?
 - o If YES, what has enabled you to have this information? [collect information about opportunities]
 - o If NO, what has prohibited you from accessing this information? [collect information about constraints]
9. What steps do you think should be taken to ensure that aquaculture producers have up-to-date information about the current market for fish in Cambodia?
 10. Please describe your current relationship with your customers. [Provide the respondent with 1-2 minutes to describe their consumer base and current relationships with their customers]
 - o Would you say that you have a good working relationship with individual consumers and local businesses?
 - If YES, why? [collect information about opportunities]
 - If NO, why not? [collect information about constraints]
 - o In what areas do you think that your relationship with individual consumers and businesses could be improved?
 11. Do you have strong relationships with other aquaculture producers in Cambodia?
 - o If YES, who do you have these relationships with and what has helped you to build these relationships? [collect information about opportunities]
 - o If NO, what has prohibited you from forming strong relationships with other hatcheries and nurseries? [collect information about constraints]
 12. What, if anything, do you think could be done to improve your relationship with other aquaculture producers?
 13. *Would you join and participate in an Aquaculture Association or a similar social network to improve linkages and collaboration between value chain actors?*
 - o *If YES, why? [collect information about opportunities]*
 - o *If NO, why not? [collect information about constraints]*
 14. *From your point of view, what should be the overall goal(s) of this Association?*

2. COLLECTORS (WHOLESALEERS & PROCESSORS)

Topic 1. Aquaculture Industry

Let's talk about your vision of the aquaculture sector in Cambodia and what you believe are the constraints and opportunities to develop the commercial aquaculture in this country. Based on your understanding of the sector and past experiences:

Constraints and opportunities to develop commercial aquaculture in Cambodia

1. *Are you satisfied with the quality and availability of fish from Cambodian-based aquaculture producers?*
 - o *If YES, what has led you to form this conclusion? [collect information about opportunities]*
 - o *If NO, what are the main issues and how could it they improved? [collect information about constraints]*
2. *Please describe the quality requirements for buying and selling fish in Cambodia. [Provide the respondent with 1-2 minutes to describe any current quality requirements]*
 - o *Is it more difficult to meet market requirements for certain species?*
 - *If YES, why? [collect information about opportunities]*
 - *If NO, why not? [collect information about constraints]*
3. *What current practices do you follow to ensure good hygiene and sanitation in the trading and processing of your fish?*
 - *Where did you learn these practices? [ask for specific details]*
 - *Is it important to practice good hygiene and sanitation to access the market? [ask for specific details]*
4. *From your point of view, what processed fish products will be in high demand in the coming years? Please explain.*

Topic 2. Program Implementation

Barrier and facilitators to program implementation

Let's talk about the CAST project and what you believe are the barriers and facilitators to implementing the project. Based on your understanding of the sector and past experiences:

5. *What are the main barriers to increasing the quantity and improving the quality of fish available to you each year?*
 - *Prompt for: at least 1-2 barriers to increasing the quantity of fish and 1-2 barriers for improving the quality of fish*
6. *What are the main barriers that you face when trying to market your fish?*
 - *Prompt for: access to marketing information, access to customer, transportation capacity, competitive price [prompt for 2-3 barriers for marketing]*
7. *What, if any, recommendations do you have for potential solutions to these barriers?*
 - *Prompt for: capacity (e.g., training on processing technique), coordination with other value chain actors (e.g., communication and exchange), infrastructure (e.g., access to roads and electricity), investment capacity (e.g., access to loans)*
 - o *Why do you think these barriers have not been addressed in the past?*
8. *What, if any, facilitators currently exist that help you to trade and process fish?*

- Prompt for :specific demand from urban areas or export; new markets, new technique, improved road and transportation

Support services needed & awareness

Let's talk about the CAST project and what type of service and support the project can provide.

9. Do you currently receive or have you in the past received support services from any other aquaculture projects?
 - a. If YES, please describe the type of services you received and the duration for which you received these services (e.g., one day, two months, three years)
 - iii. What kind of support services have you found most and least useful for your business?
 - b. If NO, please describe the type of services that you think would most benefit your business (e.g., technology for storage, training for SPS and quality improvement).
 - iv. What, if any, barriers do you think have prevented you from receiving these services from other aquaculture projects?
10. What support services do you think CAST should offer to wholesalers/processors operating in Cambodia? Please explain. [Respondent should answer this question first before interviewer asks the following three questions about additional support]
 - a) What, if any, additional support is needed to improve the quality of fish?
 - b) What, if any, additional support is needed to increase volume of production?
 - c) What, if any, additional support is needed to improve marketing and access to market?
11. What support services do think CAST should offer to Cambodian hatcheries, nurseries, and aquaculture producers to help improve the quality of their products?
 - How do you think that these interventions would increase the quantity and improve the quality of fish traded and processed by your business?

Topic 3. Relationship building

Let's talk about access to knowledge and how you interact with other actors of the aquaculture sector.

12. How and from where do you get information about the market for fish in Cambodia?
 - Do you currently have enough information about the market for Cambodian fish?
 - o If YES, what has enabled you to have this information? [collect information about opportunities]
 - o If NO, what has prohibited you from accessing this information? [collect information about constraints]
13. What steps do you think should be taken to ensure that aquaculture producers have up-to-date information about the current market for fish in Cambodia?
14. Please describe your current relationship with your customers. [Provide the respondent with 1-2 minutes to describe their consumer base and current relationships with their customers]
 - o Would you say that you have a good working relationship with individual consumers and local businesses?
 - If YES, why? [collect information about opportunities]
 - If NO, why not? [collect information about constraints]
 - o In what areas do you think that your relationship with individual consumers and businesses could be improved?
15. Do you have strong relationships with other aquaculture producers in Cambodia?
 - o If YES, who do you have these relationships with and what has helped you to build these relationships? [collect information about opportunities]

- o *If NO, what has prohibited you from forming strong relationships with other hatcheries and nurseries? [collect information about constraints]*
- 16. What, if anything, do you think could be done to improve your relationship with other aquaculture producers?
- 17. Would you join and participate in an Aquaculture Association or a similar social network to improve linkages and collaboration between value chain actors?
 - o If YES, why? [collect information about opportunities]
 - o If NO, why not? [collect information about constraints]
- 18. From your point of view, what should be the overall goal(s) of this Association?

HORECA and SUPERMARKET

Topic 1. Aquaculture Industry

Constraints and opportunities to develop commercial aquaculture in Cambodia

Let's talk about your vision of the aquaculture sector and the constraints and opportunities to develop commercial aquaculture in Cambodia. Based on your understanding of the sector:

1. Are you currently satisfied with the availability and quality of fish being purchased by your business?
[Provide the respondent with 1-2 minutes to describe their level of satisfaction and provide examples to support their answer]
 - o Prompt for: seasonality and traceability
2. What requirements does your business have in place to ensure that you are buying and selling quality fish to customers?
 - o Prompt for: information about size, species, and quantity
3. Are these requirements reliably met by fish sourced from the Cambodian aquaculture industry?
 - o If YES, what do you think value chain actors are doing to help ensure a high quality product? [collect information about opportunities]
 - o If NO, why not and what improvement do you think need to be made? [collect information about constraints]
4. *Please share your thoughts about the current level of communication and information sharing between actors within the Cambodian value chain. Provide 1-2 examples.*
 - o *Prompt for: information and communication regarding price, quality requirement, and access to new technology (or lack thereof)*
 - o *What should be done to improve communication and information sharing within the Cambodian aquaculture industry?*
5. What opportunities currently exist for improvements in the production, transport, and processing of fish within the aquaculture value chain?
 - o What is needed to improve the performance of fish processing and/or the post-harvest storage and handling of Cambodian-sourced fish?
 - Prompt for: issues related to certain forms of processing (e.g., fermented, smoked, dried, filleted, skinned) and storage capacity and quality control
6. From your point of view, what are the aquaculture processed products that have the highest potential for growth in Cambodia? Please explain.

Constraints and opportunities to develop a traceability and quality control system for aquaculture product

Let's talk about SPS and quality control system and what you believe are the constraints and opportunities to develop and enforce a quality control and traceability system in the aquaculture sector. Based on your understanding of the sector and past experiences:

7. *What regulations should be put in place to ensure that quality inputs are available throughout the aquaculture value chain?*
 - o *Prompt for: feed produced in Cambodia or imported and/or quality control/biosecurity measures*
8. *What should be done to improve the regulation of quality standards for aquaculture products within the aquaculture value chain?*
 - o *Prompt for: standards for the different processed products and fish on ice or frozen*
 - o *Based on your experience with other sectors (e.g., vegetable), what, if any, additional regulations should be developed for the aquaculture industry in Cambodia?*
9. *What do you think are the main constraints to developing a traceability system for aquaculture products in Cambodia?*
10. *What do you think are the main opportunities to developing a traceability system for aquaculture products in Cambodia (e.g., species, consumer group target, existing experiences)?*
 - *Which existing value chain actors should we involve in the conversation about developing a traceability system for this purpose?*
 - *What new or addition value chain actors should we involve in this discussion?*

Topic 3. Relationship building

Let's talk about access to knowledge and how you interact with other actors of the aquaculture sector.

11. *How and from where do you get information about the market for fish in Cambodia?*
 - *Do you currently have enough information about the market for Cambodian fish?*
 - o *If YES, what has enabled you to have this information? [collect information about opportunities]*
 - o *If NO, what has prohibited you from accessing this information? [collect information about constraints]*
12. *What steps do you think should be taken to ensure that hatcheries and nurseries have up-to-date information about the current market for fingerlings in Cambodia?*
13. *Please describe your current relationship with your customers. [Provide the respondent with 1-2 minutes to describe their consumer base and current relationships with their customers]*
 - o *Would you say that you have a good working relationship with individual consumers and local businesses?*
 - *If YES, why? [collect information about opportunities]*
 - *If NO, why not? [collect information about constraints]*
 - o *In what areas do you think that your relationship with individual consumers and businesses could be improved?*
15. *Would you join and participate in an Aquaculture Association or a similar social network to improve linkages and collaboration between value chain actors?*
 - o *If YES, why? [collect information about opportunities]*
 - o *If NO, why not? [collect information about constraints]*

From your point of view, what should be the overall goal(s) of this Association?

FEED MILLS AND IMPORTERS

Topic 1. Aquaculture Industry

Let's talk about your vision of the aquaculture sector in Cambodia and what you believe are the constraints and opportunities to develop the commercial aquaculture in this country. Based on your understanding of the sector and past experiences:

Constraints and opportunities to develop commercial aquaculture in Cambodia

1. How many metric tons of aquaculture feed do you think are required to sustain the Cambodian aquaculture sector each year? Please explain.
2. What do you think the Cambodian aquaculture feed market will look like in five years?
 - What are the main drivers of growth within the sector and how they evolved over the past 10 years?
3. What species of fish do you primarily target with your aquaculture feed? Why have you chosen to target these species?
4. What parts of the country do you typically target for the sale and distribution of your aquaculture feed? Why have you chosen to focus your efforts in these areas?
5. [Question for feed mills only] If you do not have a feed mill currently producing aquaculture feed – do you plan to invest in one in the next 3-5 years?
 - a) If YES, why? [collect information about opportunities]
 - b) If NO, why not? [collect information about constraints]
6. Please describe your current distribution strategy/system?
 - a) *Who are you currently selling your feed to and where are their farms?*
 - b) *What type of contact to you currently have with feed distributors?*
 - c) *What do you think could be improved about the current distribution strategy/system?*

Topic 2. Program implementation

Let's talk about the CAST project and what you believe are the barriers and facilitators to implement the project. Based on your understanding of the sector and past experiences:

Barriers and facilitators to program implementation

7. What are the main barriers to increasing the quantity and improving the quality of aquaculture feed available to the Cambodian aquaculture sector each year?
 - Prompt for: at least 1-2 barriers to increasing the quantity of feed and 1-2 barriers for improving the quality of feed
8. What are the main barriers that you face when trying to market your feed?
 - Prompt for: access to marketing information, access to customer, transportation capacity, competitive price [prompt for 2-3 barriers for marketing]
9. What, if any, recommendations do you have for potential solutions to these barriers?
 - Prompt for: capacity (e.g., training on processing technique), coordination with other value chain actors (e.g., communication and exchange), infrastructure (e.g., access to roads and electricity), investment capacity (e.g., access to loans)
 - o Why do you think these barriers have not been addressed in the past?

10. What, if any, facilitators currently exist that help you market and sell your aquaculture feed?
- Prompt for: access to customers; technical supports to customers

Topic 3: Relationship building

Let's talk about access to knowledge and how you interact with other actors of the aquaculture sector.

11. What role should feed companies and feed importers play in supporting hatcheries, nurseries, and aquaculture producers in Cambodia?
- Prompt for: ability and interest in providing technical support
12. Please describe your current relationship with your customers. [Provide the respondent with 1-2 minutes to describe their consumer base and current relationships with their customers]
- o Would you say that you have a good working relationship with individual consumers and local businesses?
 - If YES, why? [collect information about opportunities]
 - If NO, why not? [collect information about constraints]
 - o In what areas do you think that your relationship with individual consumers and businesses could be improved?
13. *Do you have strong relationships with other feed distributors in Cambodia?*
- o *If YES, who do you have these relationships with and what has helped you to build these relationships? [collect information about opportunities]*
 - o *If NO, what has prohibited you from forming strong relationships with other feed distributors? [collect information about constraints]*
14. What, if anything, do you think could be done to improve your relationship with other hatcheries and nurseries?
15. Would you join and participate in an Aquaculture Association or a similar social network to improve linkages and collaboration between value chain actors?
- o If YES, why? [collect information about opportunities]
 - o If NO, why not? [collect information about constraints]
16. From your point of view, what should be the overall goal(s) of this Association?

FEED DISTRIBUTORS

Topic 1. Aquaculture Industry

Let's talk about your vision of the aquaculture sector in Cambodia and what you believe are the constraints and opportunities to develop the commercial aquaculture in this country. Based on your understanding of the sector and past experiences:

Constraints and opportunities to develop Commercial aquaculture in Cambodia

1. How many metric tons of aquaculture feed do you think are required to sustain the Cambodian aquaculture sector each year? Please explain.
2. In the past two years:
 - a) Has your volume of commodities (i.e., size of your inventory) and value of sales increased, decreased, or stayed the same?
 - o Why do you think that these changes occurred?
 - b) Has your total number of customers increased, decreased, or stayed the same?
3. Are customers buying more or less feed today than they were two years ago?
 - a. What, if anything, do you think is responsible for this change in purchasing behavior?
4. *What are your main target species of fish? Why have you chosen these species?*
5. Please describe your current distribution strategy/system?
 - a) How many hatcheries, nurseries, and/or aquaculture producers are currently purchasing feed directly from you each month?
 - b) How many other feed distributors are you currently working with?
 - c) Do you provide customer with the feed before they make a payment?
 - o If yes, why? [collect information about opportunities]
 - What are the rules that govern these agreements?
 - o If no, why not? [collect information about constraints]

Topic 2. Program Implementation

Let's talk about the CAST project and what you believe are the barriers and facilitators to implementing the project. Based on your understanding of the sector and past experiences:

Barrier and facilitators to program implementation

6. What are the main barriers to increasing the quantity and improving the quality of aquaculture feed available to the Cambodian aquaculture sector each year?
 - Prompt for: at least 1-2 barriers to increasing the quantity of feed and 1-2 barriers for improving the quality of feed
7. What are the main barriers that you face when trying to market your feed?
 - Prompt for: access to marketing information, access to customer, transportation capacity, competitive price [prompt for 2-3 barriers for marketing]
8. *What, if any, recommendations do you have for potential solutions to these barriers?*
 - Prompt for: capacity (e.g., training on processing technique), coordination with other value chain actors (e.g., communication and exchange), infrastructure (e.g., access to roads and electricity), investment capacity (e.g., access to loans)
 - o Why do you think these barriers have not been addressed in the past?
9. What, if any, facilitators currently exist that help you market aquaculture feed?

- Prompt for: access to customers; technical supports to customers

Support services needed & awareness

Let's talk about the CAST project and what type of service and support the project can provides.

10. What support services, if any, do you currently provide to Cambodian hatcheries, nurseries, or aquaculture producers?
 - Prompt for: technical support, financial support as loan in kind
 - If you are not providing support service, why aren't you doing so?
 - o Prompt for: lack of knowledge, limited staff, no demand
 - o What would need to change for you to provide technical support to your customers in the future?
11. What type of support services would help you increase the amount aquaculture feed sales in the future?
 - Prompt for: technical training, business training, more connection with farmers, and education material to distribute to farmers

Topic 3: Relationship building

Let's talk about access to knowledge and how you interact with other actors of the aquaculture sector.

12. How and from where do you get information about best practices for aquaculture techniques and up-to-date information about aqua-feed technologies?
 - Do you currently have enough information about aquaculture techniques and aqua-feed technologies?
 - o If YES, what has enabled you to have this information? [collect information about opportunities]
 - o If NO, what has prohibited you from accessing this information? [collect information about constraints]
13. What steps do you think should be taken to ensure that aquaculture producers have up-to-date information about the current market for fish in Cambodia?
14. *Please describe your current relationship with your customers. [Provide the respondent with 1-2 minutes to describe their consumer base and current relationships with their customers]*
 - o *Would you say that you have a good working relationship with individual consumers and local businesses?*
 - *If YES, why? [collect information about opportunities]*
 - *If NO, why not? [collect information about constraints]*
 - o *In what areas do you think that your relationship with individual consumers and businesses could be improved?*
15. *Do you have strong relationships with other feed distributors in Cambodia?*
 - o *If YES, who do you have these relationships with and what has helped you to build these relationships? [collect information about opportunities]*
 - o *If NO, what has prohibited you from forming strong relationships with other feed distributors? [collect information about constraints]*
16. What, if anything, do you think could be done to improve your relationship with other feed distributors?

MICRO FINANCE INSTITUTION AND INSURANCE

Topic 1. Aquaculture Industry

Let's talk about your vision of the aquaculture sector in Cambodia and what you believe are the constraints and opportunities to develop the commercial aquaculture in this country. Based on your understanding of the sector and past experiences:

Constraints and opportunities to develop commercial aquaculture in Cambodia

1. What is your general impression about the aquaculture industry in Cambodia? Please share 2-3 examples that support your thoughts about this topic.
 - Prompt for: trend and opportunities for MFI and Insurance Cie
2. What changes should be made the aquaculture system in Cambodia to increase the profitability of producers and hatcheries?
 - a. Prompt for: technical improvement; market access; introduction of high quality genetic strains, trend, opportunities for MFI and Insurance Cie
3. Is your bank or enterprise currently engaged in the Cambodian aquaculture industry?
 - a. If YES, in what ways are you involved with this sector? [collect information about opportunities]
 - i. Please describe 2-3 lessons learned about the industry through this engagement/involvement.
 - b. If NO, why not? [collect information about constraints]
 - i. Prompt for: risk, knowledge of the sector, market
4. What, if anything, should to be done to help hatcheries, nurseries, and aquaculture producers and feed mills access financial services in Cambodia?
5. Please describe the different types of risks associated with your business getting involved with the aquaculture sector.
 - a) What, if anything, can CAST do to help mitigate this risk?

Topic 2. Program Implementation

Let's talk about CAST project and what you believe are the barriers and facilitators to implement the project. Based on your understanding of the sector and past experiences:

Barrier and facilitators to program implementation

6. What are the main barriers to providing financial services to hatcheries, nurseries, and aquaculture producers?
 - Prompt for: at least 1-2 barriers to providing these services to these beneficiaries
7. What are the main barriers that you face when trying to provide financial services to community members and businesses?
 - Prompt for: low return, no collaterals, limited market
8. What, if any, recommendations do you have for potential solutions to these barriers?
 - o Prompt for: capacity building (e.g. training), coordination with other actors of the value chain (e.g., communication and exchange), infrastructure (e.g., access to road, electricity), and investment capacity (e.g., access to loan and financial mechanism)
 - o Why do you think these barriers have not been addressed in the past?
9. What, if any, facilitators currently exist that help you to provide financial services to community members

and businesses?

- *Prompt for: access to quality fingerlings/clean water, help from neighbors or family members, returning customers/word of mouth, proximity to road/transportation*

Topic 3: Relationship building

Let's talk about access to knowledge and how you interact with other actors of the aquaculture sector.

10. What type of information, knowledge, skills and partners would you require to get actively involved in the Cambodian aquaculture sector?
11. Do you have enough connection with fish farmers and other actors of the value chain?
 - Prompt for: what is existing and what is missing
 - How can CAST help to foster these relationships?
12. *Please describe your current relationship with your customers. [Provide the respondent with 1-2 minutes to describe their consumer base and current relationships with their customers]*
 - o *Would you say that you have a good working relationship with individual consumers and local businesses?*
 - *If YES, why? [collect information about opportunities]*
 - *If NO, why not? [collect information about constraints]*
 - o *In what areas do you think that your relationship with individual consumers and businesses could be improved?*

ANNEX D: STANDARD AND CUSTOM INDICATORS

Standard Indicator# 1: Yield of targeted agricultural commodities among program participants with USDA assistance						
Yield per square meter of pond or per cubic meter of cage is a measure of productivity. Yield is a measure of the total output of production of fish, divided by the total number of units in production square meter for pond, cubic meters of cage for cage aquaculture.						
	Indicator value	95% CI Lower bound	95% CI Upper bound	Number of records	Standard Error	Standard Deviation
TREATMENT						
Aquaculture pond						
Indicator value (kg/m ²)	4.77	4.48	5.06	507	0.15	3.34
Age 15-29	4.93	2.93	6.92	15	0.93	3.60
Age 30+	4.77	4.47	5.06	492	0.15	3.33
Male	4.81	4.50	5.13	443	0.16	3.38
Female	4.46	3.71	5.22	64	0.38	3.03
Aquaculture cage						
Indicator value (kg/m ³)	44.00	41.58	46.18	402	1.17	23.43
Age 15-29	48.48	40.00	56.96	25	4.11	20.55
Age 30+	43.58	41.18	45.97	377	1.22	23.60
Male	44.32	41.87	46.77	364	1.25	23.76
Female	39.66	33.13	46.18	38	3.22	19.85
CONTROL						
Aquaculture pond						
Indicator value (kg/m ²)	2.11	1.88	2.34	183	0.12	1.60
Age 15-29	1.95	-3.43	7.32	3	1.25	2.16
Age 30+	2.11	1.88	2.35	180	0.12	1.59
Male	2.10	1.84	2.36	157	0.13	1.64
Female	2.17	1.62	2.72	26	0.26	1.35
Aquaculture cage						
Indicator value (kg/m ³)	32.00	29.31	34.92	103	1.41	14.35
Age 15-29	27.99	12.02	43.96	6	6.21	15.22
Age 30+	32.37	29.48	35.26	97	1.46	14.34
Male	32.54	29.70	35.38	100	1.43	14.33
Female	17.90	4.47	31.33	3	3.12	5.41

Standard Indicator# 2: Number of hectares under improved management practices or technologies that promote improved climate risk reduction and/or natural resource		
This indicator measures the area in hectares where USDA-promoted management practices or improved technologies that reduce climate risk and improve land, marine, and other natural resources management were applied during the reporting year to areas managed or cultivated by producers participating in a USDA-funded activity.		
	TREATMENT	CONTROL
n	943	300
Indicator value (ha)	44.3	13.8

Standard Indicator# 3: Number of hectares under improved management practices or technologies with USDA assistance		
This indicator measures the area in hectares where USDA-promoted management practices or improved technologies were applied during the reporting year to areas managed or cultivated by producers participating in a USDA-funded activity. This indicator measures adoption of i) aquaculture management practices and technology; ii) climate adaptation practices and technology; iii) other practices and technology (post-harvest, marketing and business management) hatcheries, nurseries, producers.		
	TREATMENT	CONTROL
n	943	300
Indicator value (ha)	61.2	20.05
Aquaculture Management	19.59	1.75
Climate Adaptation	20.25	10.07
Other	48.60	17.66
Age 15-29	2.93	0.00
Age 30+	58.30	20.48
Male	58.58	20.08
Female	2.66	0.40

Standard Indicator# 4: Number of individuals in the agriculture system who have applied improved management practices or technologies with USDA assistance		
This indicator measures the total number of agriculture system actors participating in USDA-funded activities who have applied improved management practices and/or technologies promoted by USDA anywhere within the food and agriculture system during the reporting year. This indicator measures adoption by agriculture system actors of i) aquaculture management practices and technology; ii) climate adaptation practices and technology; iii) other practices and technology (post-harvest, marketing and business management) for hatcheries, nurseries, producers, collectors, wholesalers and processors.		
	TREATMENT	CONTROL
n	1,039	339
Indicator value (# individuals)	178	43
Aquaculture Management	33	6
Climate Adaptation	71	9
Other	93	31
Smallholder	43	8
Non-smallholder	-	-
Private sector	7	8
Age 15-29	8	1
Age 30+	170	42
Male	159	38
Female	19	5

Standard Indicator# 18: Value of annual sales of farms and firms receiving USDA assistance		
This indicator measures the value in U.S. dollars of the total amount of sales of products and services by USDA-assisted farms and firms during the reporting year within USDA-supported agricultural commodity value chains or markets. It includes the value of sales of hatcheries, nurseries, producers, collectors, wholesalers and processors.		
	TREATMENT	CONTROL
n	1,014	332
Indicator value (\$US)	48,866,778	16,560,657
Smallholder	11,440,825	2,607,840
Non-smallholder	1,435,500	0
Microenterprise	19,359,796	13,952,817
Small enterprise	70,000	0
Medium enterprise	0	0
Large enterprise	0	0
Age 15-29	30,376,922	16,232,798
Age 30+	1,929,199	327,859
Male	24,593,213	12,912,056
Female	7,712,908	3,648,601

Standard Indicator# 19: Volume of commodities (metric tons) sold by farms and firms receiving USDA assistance		
This indicator will collect the volume (as calculated in gross metric tons (MT)) of sales of targeted commodities by farms and firms receiving USDA assistance. This includes the volume of all sales of fish, fingerlings and processed fish, not just the volume of farm-gate sales. It includes the volume of sales of hatcheries, nurseries, producers, collectors, wholesalers and processors.		
	TREATMENT	CONTROL
n	1,014	332
Indicator value (MT)	15,477.77	3,156.05
Smallholder	6,769.12	1,192.28
Non-smallholder	1,203.00	0
Microenterprise	7,498.64	1,963.77
Small enterprise	7.00	0
Medium enterprise	0	0
Large enterprise	0	0
Age 15-29	781.33	136.37
Age 30+	14,696.43	3,019.68
Male	11,248.60	2,286.93
Female	4,277.82	869.12

Custom Indicator#2: Total area of ponds (square meters) under improved management practices or technologies with USDA assistance		
This indicator measures the area in square meters where USDA-promoted management practices or improved technologies were applied during the reporting year to areas managed or cultivated by producers participating in a USDA-funded activity. This indicator measures adoption of i) aquaculture management practices and technology; ii) climate adaptation practices and technology of hatcheries, nurseries and producers (for cage only the surface in square meter is taken into account)		
	TREATMENT	CONTROL
n	943	300
Indicator value (m²)	408,789	3,958
Hatcheries	250,904	114,218
Nurseries	21,850	800
Producers	136,036	3,958.00
Aquaculture Management	206,301	3,610
Climate Adaptation	202,488	348

Custom Indicator#3: Number of hatcheries or feed mills that are supplying seed or feed that meets improved quality standards		
This output indicator will measure the number of hatcheries and feed mills that are supplying the value chain with product (i.e., fingerlings and feed) that meets international or otherwise acceptable quality standards. For feed mills this indicators measure the compliance to international standards when producing fish feed. For hatcheries it takes into consideration 13 different practices, including biosecurity and hatcheries management and transport of fingerlings.		
	TREATMENT	CONTROL
n	25	13
Indicator value (# firms)	0	0
Hatcheries	0	0
Feed mills	0	0

Custom Indicator#4: Number of beneficiaries who received market information about price and availability of aquaculture products		
This indicator measure the number of beneficiaries that access market information about fish prices including processed fish, price of and availability of inputs and quality standard.		
	TREATMENT	CONTROL
n	1,031	339
Indicator value (# individuals)	817	262
Hatcheries	14	7
Nurseries	8	0
Producers	713	230
Collectors	23	8
Wholesalers	20	5
Processors	25	7
Feed distributors	14	5

Custom Indicator #5: Number of market actors who are compliant with standard SPS best practices and/or are using an independent quality seal to market their products		
This indicator will measure the number of beneficiaries in the post-production segment of the value chain that apply standard SPS best practices and/or use an independent quality seal reserved for high-quality Cambodian-raised fish.		
	TREATMENT	CONTROL
n	71	32
Indicator value (# individuals)	0	0
Collectors	0	0
Wholesalers	0	0
Processors	0	0

Custom Indicator#6: Number of farms that increased the number, size, or amount of ponds, cages or equipment with USDA assistance						
This indicator measures the increased size and scope of production equipment or area of production activities. It measures the area of pond (m ²) and volume of cage (m ³) per farm, the average number of ponds and cages per farm and the number of farm equipped with well and aeration. For hatcheries, it also measure the number of tanks and the average number of equipment (oxygen tank, grader, refrigerator, scale, hapa net hauling tank with oxygen, seine and dip net and sechhi disk)						
	Indicator value	95% CI Lower bound	95% CI Upper bound	Number of records	Standard Error	Standard Deviation
TREATMENT						
Producers - pond						
Average area of pond (m ²)	1,866.73	1,541.28	2,192.19	725	165.77	4,463.62
Average number of ponds	1.57	1.47	1.66	507	0.05	1.05
Average number of pumps	1.51	1.13	1.90	507	0.19	4.38
Number of pond farms with aeration	6	-	-	507	-	-
Number of pond farms equipped with a well	53	-	-	507	-	-
Producers - cage						
Average volume of cages (m ³)	96.57	79.68	113.47	515	8.60	195.11
Average of number of cages	1.39	1.31	1.48	402	0.04	0.89
Number of cage farms with aeration	31	-	-	402	-	-
Hatcheries						
Average area of ponds in hatchery (m ²)	2,951.12	2,073.54	3,828.69	103	442.44	4,490.27
Average number of ponds & cages	11.96	7.30	16.62	25	2.26	11.28
Average number of tanks	5.50	3.05	7.95	16	1.15	4.59
Number of hatcheries equipped with a well	3.00	-	-	17	-	-
Average pump per hatchery	2.18	1.26	3.09	17	0.43	1.78
Number of hatcheries with aeration	4.00	-	-	17	-	-
Average of number of equipment per hatchery	6.06	4.89	7.23	17	0.55	2.28
CONTROL						
Producers - pond						
Average area of pond (m ²)	1,431.1	975.20	1,887.0	238	231.4	3570.3
Average number of ponds	1.4	1.30	1.5	183	0.05	0.7
Average number of pumps	1.3	1.10	1.4	183	0.10	0.9
Number of pond farms with aeration	1	-	-	183		-
Number of pond farms equipped with a well	5	-	-	183		-
Producers - cage						
Average volume of cages (m ³)	105.7	88.20	123.1	166	8.80	114.0
Average of number of cages	1.7	1.50	1.9	103	0.11	1.1
Number of cage farms with aeration	12			103		
Hatcheries						
Average area of ponds in hatchery (m ²)	5220.3	2970.3	7470.4	30	1100.2	6025.8
Average number of ponds & cages	9.2	5.8	12.6	14	1.6	5.9
Average number of tanks	10.9	1.5	20.3	11	4.2	14.0

Number of hatcheries equipped with a well	0	-	-	14	-	-
Average pump per hatchery	2.9	2.0	3.9	13	0.4	1.6
Number of hatcheries with aeration	5	-	-	13	-	-
Average of number of equipment per hatchery	8.1	7.4	8.8	13	0.3	1.2

Custom Indicator#7: Number of value chain actors with increased capacity for distribution including processing and/or other value addition practice						
This indicator is intended to measure the number and type of tangible investments that value chain actors make in their businesses. Benchmark figures as below Storage assets include :i) refrigerators, ii) tanks for live fish with aeration, ii) tanks for live fish without aeration, iv) tanks for transporting dead fish and v) cooler boxes. Transformation assets include: i) solar dryers; ii) smoke fish stoves Transportation assets include: i) motorcycles; ii) carts; iii) cars; iv) motorized boats; v) mini-vans; vi) small trucks (4 wheels); vii) large trucks (6 or more wheels).						
	Indicator value	95% CI Lower bound	95% CI Upper bound	Number of records	Standard Error	Standard Deviation
TREATMENT						
Collectors						
Average storage assets	28.1	11.8	44.4	24	7.9	38.6
Average transformation assets	0.2	-0.04	0.37	24	0.1	0.7
Average transport assets	2.3	1.4	3.2	24	0.4	2.1
Wholesalers						
Average storage assets	32.7	10.8	54.6	21	10.5	48.1
Average transformation assets	0.3	-0.1	0.7	21	0.2	0.9
Average transport assets	3.1	1.6	4.7	21	0.7	3.3
Processors						
Average storage assets	4.9	1.8	8.0	24	1.5	7.6
Average transformation assets	5.8	1.6	10.0	24	2.0	10.4
Average transport assets	1.6	1.2	2.0	24	0.2	1.0
CONTROL						
Collectors						
Average storage assets	6.2	3.1	9.3	16	1.5	5.9
Average transformation assets	0.0	0.0	0.0	16	0.0	0.0
Average transport assets	2.6	1.7	3.6	16	0.4	1.7
Wholesalers						
Average storage assets	23.0	-0.8	46.8	8	10.0	28.4
Average transformation assets	0.0	0.0	0.0	8	0.0	0.0
Average transport assets	2.8	1.7	3.8	8	0.5	1.3
Processors						
Average storage assets	4.6	1.0	8.3	8	1.5	4.3
Average transformation assets	6.4	1.3	11.5	8	0.4	1.7
Average transport assets	2.4	1.9	2.8	8	0.2	0.5

Custom Indicator#10: Number of post-production market actors who report an increase in volume or improvement in the quality of freshwater fish in the aquaculture value chain.						
This indicator will measure the number of aquaculture producers and wholesalers who buy and sell fish that report an overall increase in quality and quantity of Cambodian raised fish in the value chain. Benchmark figures as below based on the perception of beneficiaries about quality of Cambodian aquaculture fish on a scale of 1 to 5 (1: very low; 2: low; 3: average; 4: good; 5: very good)						
	Indicator value	95% CI Lower bound	95% CI Upper bound	Number of records	Standard Error	Standard Deviation
TREATMENT						
Average Collectors	3.8	3.6	4.1	23	0.1	0.6
Average Wholesalers	4.1	3.8	4.4	21	0.1	0.7
Average Processors	3.9	3.7	4.2	24	0.1	0.6
CONTROL						
Average Collectors	3.7	3.4	4.0	16	0.2	0.6
Average Wholesalers	3.1	2.8	3.4	8	0.1	0.4
Average Processors	3.8	3.2	4.3	8	0.3	0.7

Custom Indicator#11: Number of business plans developed that include marketing and distribution strategies		
This indicator measures the number of enterprises or organizations that develop an annual business plan that includes plans for marketing and/or distributing their products and/or services. Benchmark figures below include i)marketing and distribution practices and ii) recording inputs and sales value, origin of products		
	TREATMENT	CONTROL
n	1,039	339
Indicator value	93	32
Hatcheries	1	3
Nurseries	0	0
Producers	92	29
Collectors	0	0
Wholesalers	0	0
Processors	0	0
Feed distributors	0	0
Feed mills	0	0

ANNEX E: LIST OF KEY INFORMANTS

	Company – Institution	Stakeholder category	Position
1	CESAIN	CAST partners	Director
2	HARVEST II	CAST partners	Chief of Party
3	IDE	CAST partners	Innovation Lab Director
4	RUA	CAST partners	Vice Dean
5	Collector	Collector	Proprietor
6	AFD	DP	Program officer
7	IFAD - Seth	DP	Country Representative
8	JICA	DP	Program officer
9	UNIDO	DP	Project coordinator
10	Agri-Master distributor 1	Feed distributors	Proprietor
11	Agri-Master distributor 2	Feed distributors	Proprietor
12	Agri-Master distributor 3	Feed distributors	Proprietor
13	Agri-Master distributor 4	Feed distributors	Proprietor
14	Kheat Kheng Development Co.,Ltd	Feed distributors	Proprietor
15	Ly Hong Choy	Feed distributors	Marketing and Technical Managers
16	Agri-Master	Feed mill	Marketing Manager
17	Green Feed	Feed mill	Assistant Purchasing Manager Shareholder
18	FiA DFPTQ	FiA	Vice Director
19	NARDI	FiA	Vice Director
20	Rathada	Hatcheries	Proprietor
21	Beer Garden	HORECA	Proprietor
22	HAGAR	HORECA	Assistant Purchase Manager
23	Wedding Catering Group	HORECA	Manager
24	ACLEDA	MFI	SVP and Head of Credit Division
25	Rothada Hatchery	Hatchery	Proprietor
26	Davy Nursery	Nurseries	Proprietor
27	FORTE Insurance	Other	Vice President
28	Brahok Market	Processor	Owner
29	Fish processor	Processor	Proprietor
30	Cage farmer 1	Producers	Proprietor
31	Cage farmer 2	Producers	Proprietor
32	Cage farmer 3	Producers	Proprietor
33	Cage farmer 4	Producers	Proprietor
34	Pond farmer 1	Producers	Proprietor
35	Pond farmer 2	Producers	Proprietor
36	Pond farmer 3	Producers	Proprietor
37	Pond farmer 4	Producers	Proprietor
38	AEON Mall	Retailer	Purchasing Manager
39	Lucky Supermarket	Retailer	Assistant Purchasing Manager
40	Wholesaler 1	Wholesaler	Proprietor
41	Wholesaler 2	Wholesaler	Proprietor
42	Nursery3	Nurseries	Proprietor
43	Processor 3	Processor	Proprietor
44	Hatchery	Hatcheries	Proprietor
45	Collector 1	Collector	Proprietor
46	Collector 2	Collector	Proprietor

ANNEX F: ADDITIONAL RESULTS TO ANSWER BASELINE RESEARCH QUESTIONS

Baseline research question 1: What is the current productivity of feed mills, aquaculture producers and hatcheries and nurseries?

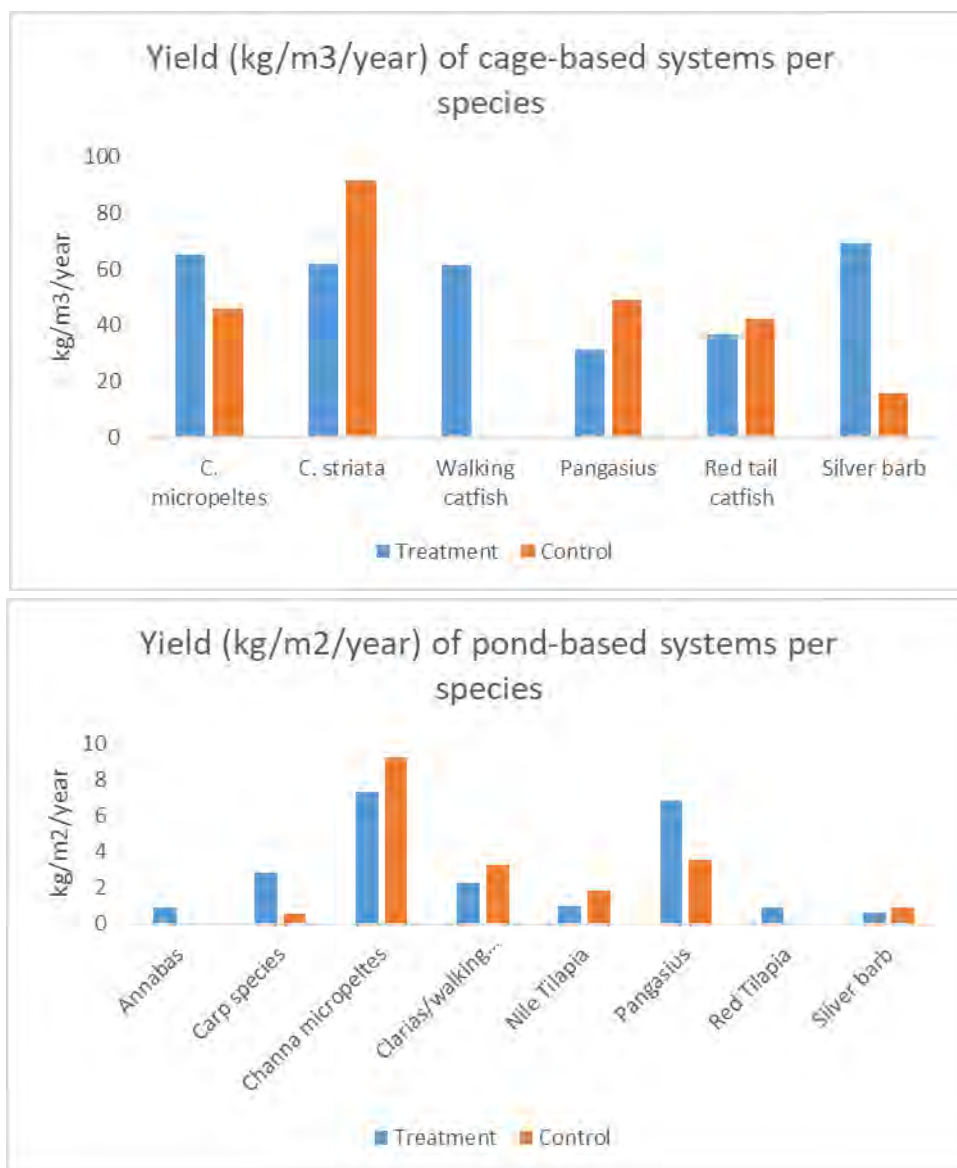


Figure A: Yield per year per species for cage (top) and pond (bottom) production systems

Baseline research question 2: What is the current soy protein and fish product trade in Cambodia?

Table A: U.S soy export to Cambodia

	2015	2016	2017	2018
<i>Cambodia Soy cultivation and production</i>				
Cultivated area (ha)	66,824	42,658	41,950	46,051
Production (Ton)	96,942	71,005	73,288	91,766
<i>US Export to Cambodia (in MT)</i>				
Soy Bean	1,068	0	1,166	1,136
Soy Cake & Meals	23,386	44,613	50,271	28,819
Flour, Consent, Isolates	4.5	13.9	18	81.5
Corn/Soy blend	226.3	0	0	0
TOTAL (MT)	24,685	44,627	51,455	30,037

(source: MAFF statistics 2019 for Cambodia cultivation and production; GATS, USDA for US export to Cambodia)

Baseline research question 5: What is the current beneficiaries' ability to access finance that is needed for business growth and development?

Frequency, the average number of loans contracted aquaculture value chain actors, and the purpose of the loans.

Table B: Access to loans in treatment and control provinces

Beneficiaries	Percentage of actor using loans	Average number of loans per actor	Top 2 purpose of loan
Treatment			
Hatcheries	24	1	Buying land for pond, warehouse Buying fish feed
Nurseries	38	1	Buying fish feed Buying fish seed
Producers	51	1.22	Buying fish feed Buying fish seed
Collectors	33	1	Buying equipment Buying vehicle (incl. boat)
Wholesalers	43	1	Other aquaculture related expense Buying equipment
Processors	35	1	Buying raw material for processing Buying land for pond, warehouse or buying cage
Feed distributors	12	1	Buying fish feed
Control			
Hatcheries	46	1	Buying land for pond, warehouse Buying fish feed
Nurseries	100	1	Repair pond
Producers	33	1.13	Buying fish feed Buying fish seed
Collectors	25	1	Buying equipment Buying vehicle (incl. boat)
Wholesalers	25	1	Buying equipment Buying vehicle (incl. boat)
Processors	38	1	Buying raw material for processing
Feed distributors	43	1	Buying fish feed Other aquaculture related expense

Table C: Number of individuals accessing agriculture-related financing

Number of individuals accessing agriculture-related financing		
	TREATMENT	CONTROL
n	1,031	339
Number of individuals who took a loan in 2018	504	114
Number of loans contracted		
Cash	534	126
In-kind	74	2
Number of loans contracted by gender and age classes		
Age 15-29	48	12
Age 30+	560	115
Male	541	119
Female	67	8

Other relevant results -

Characteristics of the Control Group population

Table D: Characteristic of the surveyed population

	Producers	Hatcheries	Nurseries	Collectors	Wholesalers	Processors	Feed distributors	MFI
n	286	13	1	16	8	8	7	6
Age								
% of proprietor 15-29	3	0	100	6	0	0	43	0
% of proprietor ≥30	97	100	0	94	100	100	57	100
% of proprietor male	90	92	100	50	50	38	71	100
% of proprietor female	10	8	0	50	50	63	29	0
Average number of employees per farm and business		0.07	0.(0)	0.3	3.1	0.7	0.5	88
Total number of employees	38	1	0	5	4	6	4	672
% of employees 15-29	3	0	-	0	0	0	25	0
% of employees ≥30	97	100	-	100	100	100	75	100
% of employees male	100	0	-	100	75	67	100	100
% of employees female	0	100	-	0	25	33	0	0

Aquaculture production systems

Table E: Production per province and species

Provinces	Total area (ha) Pond	Total Volume(m3) Cage	Volume (tons/year)	Top 3 species (by production volume)	Volume (tons per year) per top 3 species
Treatment					
Phnom Penh	32.24	20,202	2,543	1.Pangasius 2.Other 3.Silver barb	2,201 276 95
Kandal	21.42	6,841	644	1.C.micropeltes 2.Pangasius 3.Other	329 152 137
Kampong Cham	23.98	109	743	1. Pangasius 2.C.micropeltes 3.Other	366 347 19
Kampong Thom	6.83	3,428	445	1.Pangasius 2.C.micropeltes 3.C. striata	161 154 123
Siem Reap	18.60	3,347	1,099	1.C.micropletes 2. Pangasius 3.C.striata	637 312 104
Battambang	38.67	3,637	624	1.Pangasius 2.C.striata 3.Other	353 137 43
Pursat	36.18	17,373	1,930	1.Pangasius 2.C.micropletes 3.C.striata	1,262 366 269
Control					
Takeo	10.19	0	190	1.Pangasius 2.Silver barb 3.Nile tilapia	164 8 4
Kampong Chhnang	5.34	16,942	928	1.C. micropeltes 2. Pangasius 3. red tail catfish	358 262 176
Banteay Meanchey	18.76	0	76	1.Pangasius 2.Red tilapia 3.Other	46 10 8

Table F: Production system performances and characteristic per production system and per species in treatment provinces

Production system & species	Yield	Average selling price (\$/kg)	Average number of production cycle in 2018	Stocking Density*
Cage	kg/m³			Fish/m²
Snakehead <i>C. striata</i>	62.00	1.43	1	244.6
Snakehead <i>C. micropeltes</i>	65.00	1.94	0.9	166.45
Pangasius	36.86	1.38	0.7	79.0
Red tail Catfish	36.86	3.02	0.8	18.6
Silver barb	69.33	2.11	1	126.4
Walking catfish	61.44	1.08	1.4	260.0
Pond	kg/m²			Fish/m³
Snakehead <i>C. micropeltes</i>	7.30	2.26	0.96	18.45
Pangasius	6.80	1.26		11.74
Silver barb	0.64	2.23	0.84	10.95
Red Tilapia	0.91	1.81	0.95	4.87
Walking catfish	2.28	1.23	1.23	5.54

*Note: the stocking density was calculated based on a small sample of producer cultivating a single species.

Table G: Average management score of producers per province

Provinces	Aquaculture management	Marketing and distribution	Climate change adaptation
Phnom Penh	3.24	2.45	0.24
Kandal	2.97	2.31	0.82
Kampong Cham	3.41	2.15	0.62
Kampong Thom	2.58	1.85	0.66
Siem Reap	2.36	2.13	0.94
Battambang	3.48	2.35	0.57
Pursat	2.77	2.24	0.43

Note: Aquaculture management score includes 15 different practices or technologies: Handling properly dead fish; Not feeding fish with fish waste harvest; using feeding table; having a dry storage for feed; using floating pellets; using aeration; drying the pond between production cycles; control of predators; stocking certified fingerlings; using sechhi disk; using D.O meter; using water quality test kit; applying lime; applying organic fertilizer; knowing the production cost per unit

Marketing and distribution score includes: knowing his production calendar beforehand; having a contract or agreement with buyers

Climate change adaptation score includes: well for water supply, pond fenced; short production cycle

Table H: Feeding practices of aquaculture farmers

Provinces	Only Pellet (%)	Only trash fish (%)	Only Homemade feed with trash fish (%)	Only Homemade feed without trash fish (%)	Mixed Methods (%)
Target provinces					
Phnom Penh	6%	6%	13%	1%	74%
Kandal	3%	54%	2%	0%	41%
Kampong Cham	5%	36%	1%	2%	55%
Kampong Thom	7%	45%	1%	1%	46%
Siem Reap	4%	44%	0%	1%	51%
Battambang	9%	12%	1%	6%	72%
Pursat	6%	32%	1%	0%	60%
Control provinces					
Takeo	9%	2%	0%	10%	79%
Kampong Chhnang	1%	44%	3%	3%	49%
Beantay Meanchey	15%	0%	0%	12%	74%

Table I: Millions of fingerlings sold by hatcheries and nurseries in 2018 in treatment provinces

Fish	Nurseries (n=7)	Hatcheries (n=17)
Pangasius	14.500	7.33
Walking catfish	14.600	0.19
Red Tilapia	0.097	4.76
Nile Tilapia	0.118	3.41
<i>C. striata</i>	1.294	0
<i>C. micropeltes</i>	7.350	0
Snakeskin gourami	0.040	0
Red Tail catfish	0.020	0
Silver barb	0.200	2.12
Carp species	0.105	2.59

Post-harvest segment of the value chain

Table J: Volume of fish traded and top fish species traded by treatment group (standard deviation in parenthesis)

	Top aquaculture species traded	Average volume (tons/year) Aquaculture fish purchased	Average volume (tons/year) fish purchased from Cambodian aquaculture	Average % of live fish of total aquaculture volume purchased	Average % imported fish of total aquaculture volume purchased	Average spoilage (%)
Collectors	1. Channa striata 2. Walking Catfish 3. Pangasius	178.9 (246.9)	117.2 (246.7)	83.3 (23.8)	18.6 (29.2)	1.8 (2.8)
Wholesalers	1. Channa Striata 2. Walking Catfish 3. Pangasius	339.8 (293.4)	233.1 (235.9)	80.5 (25.7)	29.8 (38.1)	1.8 (3.4)
Processors	1. Channa micropeltes 2. Channa striata	182.6 (244.9)	75.8 (81.2)			4.8 (10.8)

Table K: Performance of the post-harvest segments of the aquaculture value chain (treatment group)

	Average score "Marketing and distribution"	Average score "Post-harvest and storage"	Average score "Value added"	Average storage capacity (tons)	Average total building surface (m ²)
Collectors	0.52	0.87		37.91	18.57
Wholesalers	1.20	3.10	0.10	49.05	102.25
Processors	0.76	4.05	0.00	92.97	37.94

Note : Marketing and distribution score includes 4 different practices: 1) forecasting requirement for raw material; 2) forecasting economic return of activity; 3) knowing buyers in advance; 4) having contract or agreement with buyer that indicate volume and date

Post-harvest and storage score include 6 different practices for collectors, and 5 additional practices (11 in total for wholesalers and processor): 1) applying standard practices; 2) being aware of SPS; 3) use ice; 4) use safe ice; 5) use refrigeration; 6) use refrigerated truck; 7) using gloves and mask; 8) employee washing hands; 9) fish not in contact with floor; 10) using detergent to clean equipment; 11) using specific containers to store waste from processing.

Value added score include 4 different practices : 1) label on product with identification; 2) add manufacturing date; 3) add expiration date; 4) add origin of the fish on product

Table L: Average volume of sold alive and “dead-on ice” fish purchased per actor and per province (MT per year)- Standard deviation in parenthesis.

Provinces	Collectors	Wholesalers	Processors
Target			
Phnom Penh	280.6 (90.5)	289.3 (252)	60.6 (41.8)
Kandal	86.5 (89.8)	165 (21.2)	63.5 (51.6)
Kampong Cham	182 (0)	212.3 (180.8)	56 (22.6)
Kampong Thom	25.1 (16)	309.6 (237.5)	425.8 (333.4)
Siem Reap	288 (0)	252 (0)	82 (39.6)
Battambang	139.4 (227.9)	945 (190.9)	46.8 (63.5)
Pursat	347.4 (433.2)	333 (325.5)	54 (26.8)
Control			
Takeo	34.7 (32.7)	59 (91.9)	52.5 (3.5)
Beantay meanchey	55.8 (91.8)	32.5 (27.7)	2539.8 (3276.7)
Kampong chhnang	29.1 (17.6)	750 (0)	121.2 (86.6)

Access to Information

Table M: Involvement in past project, year of last training (treatment group)

	Received Training (% of target sample)	Year of the last training	Past Beneficiary of a development project (%)
Hatcheries (n=17)	84%	81% - last 5 years	53%
Nurseries (n=8)	37%	2010 2012 (66%)/ 2016 (33%)	12%
Producers (n=918)	13%	75% - last 5 years	9%
Collectors (n=23)	4%	2015	4%
Wholesalers (n=21)	5%	2017 (50%) 2002 (50%)	10%
Processors (n=26)	43%	100% - last 5 years	8%

Table N: Main source of information of aquaculture producers, wholesalers and processors in treatment group

	Percentage of respondent who claimed to received information about	Main source of information	Last time it was received
Aquaculture producers	n=918		
Fingerling quality and prices	48.2	Other farmers (40%)	On demand (38%) Once a year (39%)
Input availability and prices	49.5	Input retailers (43%)	On demand (56%)
Fish farming techniques (feed, water management)	66.5	Other farmers (44%)	Once a year (32%)
Fish prices (live and dead on ice fish market)	66.8	Fish buyers (74%)	On demand (48%)
Fish quality and standard	4.8	Fish buyers (25%) Projects (22%)	Once a year (54%)
Technical support	11.6	Projects (52%) FiA (27%)	Once a year (60%)
Processors and wholesalers	n=47		
Processed fish prices	22	Fish buyers (66%)	On demand (66%)
Fish prices (live and dead on ice fish market)	30	Fish buyers (76%)	On demand (40%)
Fish quality and standard	8	Fish buyers (80%)	-

Climate change adaptation

Table O: Aquaculture operations affected by drought and adaptation practices per actor and per province

Province/Actors	Affected by drought (%)	Pond based system operating well (%)	Average depth of well (m)	Short species cycle (n) (%)	Moving cage (%) (
Producers					
Treatment					
Phnom Penh	16	12	-	3	57
Kandal	15	58	52.0	0	43
Kampong Cham	33	43	28.9	1	40
Kampong Thom	6	11	9.5	1	76
Siem Reap	7	16	-	10	38
Battambang	40	37	5.0	19	34
Pursat	44	28	8.0	12	30
Control					
Takeo	9	43	30	7	-
Beantay meanchey	22	24	-	8	-
Kampong Chhnang	41	19	-	9	35
Hatcheries					
Target	47.	10	16	NA	NA
Control	38	77	-	NA	NA
Nurseries					
Target	37	50	50	NA	NA
Control	0	100	-	NA	NA

Table P: Aquaculture operations affected by flood and adaptation practices per actor and per province

Province/Actors	Affected by flood (%)	Fenced Pond (%)
Producers		
Treatment		
Phnom Penh	20	50
Kandal	41	58
Kampong Cham	52	76
Kampong Thom	10	13
Siem Reap	13	14
Battambang	33	56
Pursat	27	33
Control		
Takeo	5	4
Beantay meanchey	27	32
Kampong Chhnang	32	46
Hatcheries		
Target	41	42
Control	23	14
Nurseries		
Target	50	100
Control	0	-

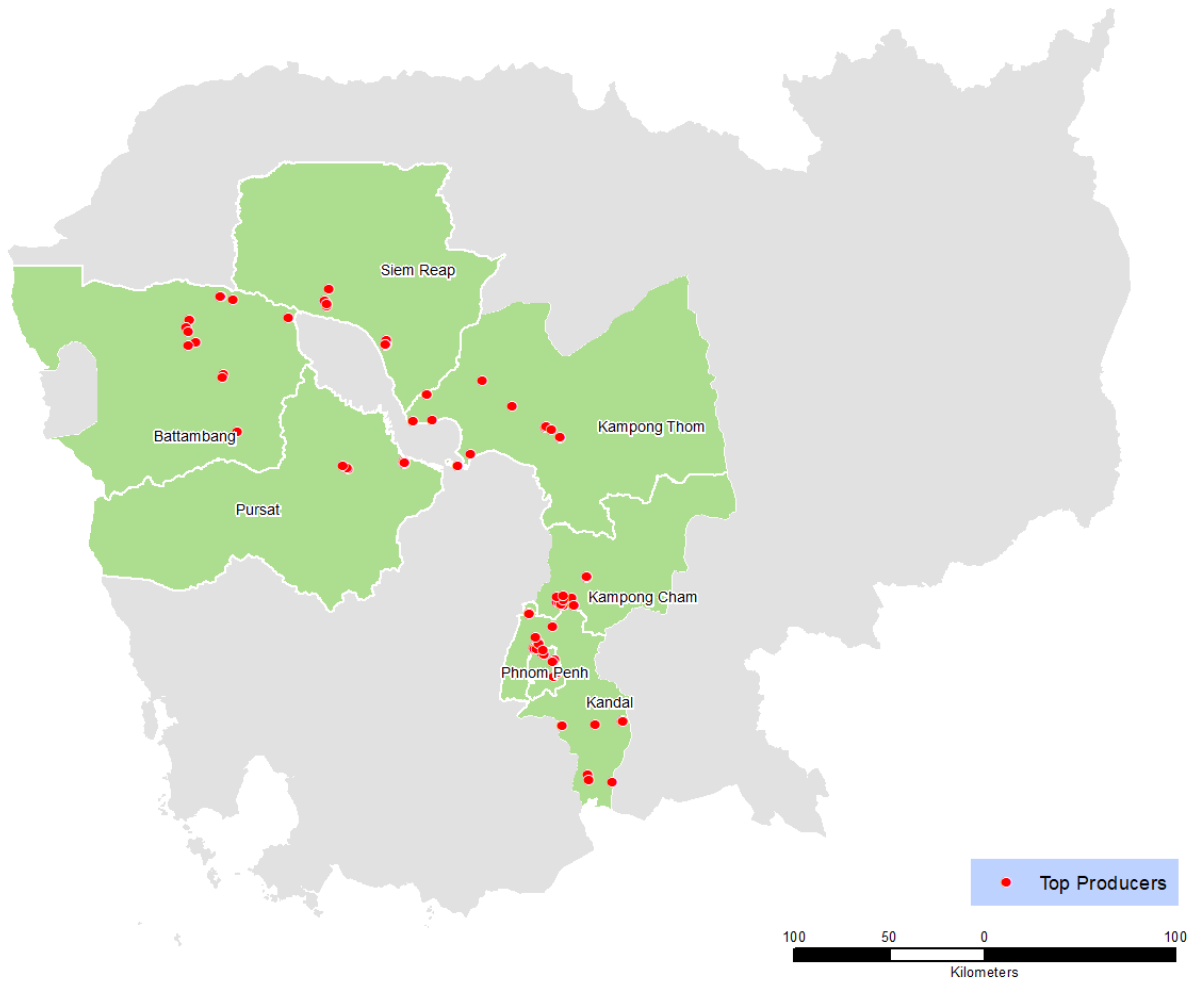


Figure B: Location of potential model farmers – the top 15 fish producers in each province (by volume produced per farm per year). Note that dots overlap in some locations due to proximity of the farms.

Table Q: Top aquaculture producer communes by province

Province/Actors	Top aquaculture producing commune	Volume (Kg per commune and per year)
Overall	Siem Reap, Siem Reap Kampong Kleang, Siem Reap Kampong Luong, Pursat Roleab, Pursat Samrong, Phnom Penh	386,400 506,540 697,550 740,450 1,681,700
Phnom Penh	Kok Rokar Ponhea Porn Prek Phnov Svay Pak Samrong	130,000 210,000 238,513 285,000 1,681,700
Kandal	Sambuor Meas Svay Ampear Preaek Ta Teaen Kampong Loung Chrouy Takeo	46,348 62,800 63,800 117,417 149,300
Kampong Cham	Kien Chrey Soutip Tang Krang Chea Lea Preaek Koy	76,847 107,000 159,491 161,200 176,000
Kampong Thom	Tboung Kravpeur Pat Sanday Kampong Chin Tboung Kampong Krabau Peam Bang	33,500 38,950 51,700 68,697 156,713
Siem Reap	Dan Run Koa Por Anlong Samnor Siem Reap Kampong Kleang	39,400 50,353 65,740 386,400 506,540
Battambang	Ta Loas Kaoh Chiveang Prey Chas Peam Aek	36,767 50,720 125,220 319,800
Pursat	Kbal Trach Anlong Tnaot Me Tuek Kampong Luong Roleab	63,720 99,621 253,516 697,550 740,450

Table R: Distribution surveyed farm per size class and province

Province	Cage			Pond		
	# small-scale	# medium scale	# large scale	# small-scale	# medium scale	# large scale
	(30-45m ³)	(45-90 m ³)	(>90m ³)	(<350 m ²)	(350-700m ²)	(>700m ²)
Treatment						
Phnom Penh		5	39	2		24
Kandal	4	9	20	20	16	28
Kampong Cham				29	32	71
Kampong Thom	16	36	4	18	18	17
Siem Reap	35	17	8	27	33	42
Battambang	14	18	9	10	12	33
Pursat	110	42	16	12	16	47
Control						
Takeo				32	30	44
Kampong Chhnang	25	36	42	12	12	19
Beantay Meanchey				2	10	22
Total	204	163	138	164	179	347

ANNEX G: COVARIATES ANALYSIS

Variable: Production Volume (kg per year) - Producers

Covariate	n	n as % of total	Mean (kg)	Standard deviation	>1SD from global mean	Correlation coefficient
	1044	-	8479.209	35585.04	-	-
Province-Battambang	87	8.333333	6646.2299	20038.01	-	-
Province-Banteay Meanchey	26	2.490421	2486.8462	2938.634	-	-
Province-Kampong Cham	119	11.39847	5964.4202	13778.48	-	-
Province-Kampong Chhnang	120	11.49425	5475.9583	8848.173	-	-
Province-Kampong Thom	102	9.770115	4374.7157	4657.058	-	-
Province-Kandal	85	8.141762	7184.6118	9222.742	-	-
Province-Phnom Penh	39	3.735632	65997.769	148789.5	X	-
Province-Pursat	224	21.45594	8723.2946	33009.92	-	-
Province-Siem Reap	154	14.75096	7087.5844	11949.07	-	-
Province-Takeo	88	8.429119	1888.6477	2972.283	-	-
Age<30	40	3.831418	5082.975	10839.68	-	-
Age ≥30	1004	96.16858	8614.5169	36218.07	-	-
Gender-Female	117	11.2069	12142.744	81770.37	-	-
Gender-Male	927	88.7931	8016.8209	24223.49	-	-
Past project participation-No	957	91.66667	9006.0554	37076.49	-	-
Past project participation-Yes	87	8.333333	2683.8966	6267.233	-	-
Loan recipient-No	391	37.45211	4933.3939	14915.04	-	-
Loan recipient-Yes	653	62.54789	10602.354	43365.47	-	-
Production type-both	9	0.862069	6000	5386.325	-	-
Production type-cage	438	41.95402	4126.895	6032.852	-	-
Production type-pond	597	57.18391	11709.739	46523.91	-	-
Control	293	28.06513	4894.2253	7962.14	-	-
Treatment	751	71.93487	9877.8775	41585.25	-	-
Pond area	597	57.18391	-	-	-	0.4705879
Cage volume	438	41.95402	-	-	-	0.4147009

Variable: Production Volume (kg per year) - Hatcheries

Covariate	n	n as % of total	Mean (kg)	Standard deviation	>1SD from global mean	Correlation coefficient
-	26	-	1,782.81	3,040.17		-
Province-Battambang	3	11.54	138.50	112.66		-
Province-Kampong Cham	2	7.69	260.00	332.34		-
Province-Kampong Chhnang	1	3.85	429.50	NA		-
Province-Kampong Thom	1	3.85	250.00	NA		-
Province-Kandal	2	7.69	5,125.00	2,651.65		-
Province-Pursat	2	7.69	50.07	7.17		-
Province-Siem Reap	3	11.54	4,254.33	7,012.84		-
Province-Takeo	12	46.15	1,802.08	2,372.84		-
Age<30	1	3.85	250.00	NA		-
Age ≥30	25	96.15	1,844.13	3,086.41		-
Gender-Female	1	3.85	2,500.00	NA		-
Gender-Male	25	96.15	1,754.13	3,099.27		-
Past project participation-No	10	38.46	2,796.80	4,001.81		-
Past project participation-Yes	16	61.54	1,149.07	2,163.76		-
Loan recipient-No	13	50.00	1,991.15	3,660.63		-
Loan recipient-Yes	13	50.00	1,574.47	2,400.27		-
Control	15	57.69	2,153.63	2,550.62		-
Treatment	11	42.31	1,277.15	3,675.76		-
Pond area	26	100.00	-	-		-0.21

Variable: Production Volume (kg per year) - Nurseries

Covariate	n	n as % of total	Mean (kg)	Standard deviation	>1SD from global mean	Correlation coefficient
-	9	-	6,291.11	7,061.38		-
Province-Battambang	2	22.22	7,800.00	8,061.02		-
Province-Kampong Cham	2	22.22	2,750.00	1,767.77		-
Province-Kampong Thom	1	11.11	900.00	NA		-
Province-Kandal	1	11.11	5,000.00	NA		-
Province-Phnom Penh	1	11.11	21,380.00	NA		-
Province-Siem Reap	1	11.11	8,202.50	NA		-
Province-Takeo	1	11.11	37.50	NA		-
Age<30	2	22.22	468.75	609.88		-
Age ≥30	7	77.78	7,954.64	7,203.71		-
Gender-Female	1	11.11	21,380.00	NA		-
Gender-Male	8	88.89	4,405.00	4,516.16		-
Past project participation-No	8	88.89	6,815.00	7,359.57		-
Past project participation-Yes	1	11.11	2,100.00	NA		-
Loan recipient-No	4	44.44	7,345.00	9,513.64		-
Loan recipient-Yes	5	55.56	5,448.00	5,463.03		-
Control	2	22.22	2,518.75	3,509.02		-
Treatment	7	77.78	7,368.93	7,637.60		-
Pond area	4	44.44				0.11

Variable: Production Volume (MT per year) - Collectors

Covariate	n	n as % of total	Mean (MT)	Standard deviation	>1SD from global mean	Correlation coefficient
-	41	-	44.58	67.38		-
Province-Battambang	3	7.32	90.33	130.42		-
Province-Banteay Meanchey	3	7.32	8.47	0.50		-
Province-Kampong Cham	1	2.44	182.00	NA	X	-
Province-Kampong Chhnang	9	21.95	12.11	9.05		-
Province-Kampong Thom	6	14.63	9.10	7.43		-
Province-Kandal	2	4.88	85.00	91.92		-
Province-Phnom Penh	3	7.32	116.67	28.87	X	-
Province-Pursat	3	7.32	60.13	36.00		-
Province-Siem Reap	1	2.44	288.00	NA		-
Province-Takeo	10	24.39	19.72	17.64		-
Age<30	3	7.32	85.33	133.95		-
Age≥30	38	92.68	41.36	61.59		-
Gender-Female	21	51.22	51.07	78.12		-
Gender-Male	20	48.78	37.76	55.12		-
Past project participation-No	38	92.68	47.64	69.11		-
Past project participation-Yes	3	7.32	5.77	1.33		-
Loan recipient-No	31	75.61	48.68	75.51		-
Loan recipient-Yes	10	24.39	31.86	30.55		-
Control	21	51.22	22.68	32.22		
Treatment	20	48.78	67.57	85.90		

Variable: Production Volume (MT per year) - Wholesalers

Covariate	n	n as % of total	Mean (MT)	Standard deviation	>1SD from global mean	Correlation coefficient
-	34	-	159.47	201.56	-	-
Province-Battambang	2	5.88	630.00	254.56	X	-
Province-Banteay Meanchey	1	2.94	283.00	NA	-	-
Province-Kampong Cham	4	11.76	215.00	178.93	-	-
Province-Kampong Chhnang	5	14.71	38.20	32.35	-	-
Province-Kampong Thom	3	8.82	308.67	224.97	-	-
Province-Kandal	3	8.82	55.67	59.72	-	-
Province-Phnom Penh	5	14.71	193.80	221.30	-	-
Province-Pursat	4	11.76	50.50	40.68	-	-
Province-Siem Reap	1	2.94	40.00	NA	-	-
Province-Takeo	6	17.65	87.33	157.79	-	-
Age ≥30	34	100.00	159.47	201.56	-	-
Gender-Female	13	38.24	192.08	245.47	-	-
Gender-Male	21	61.76	139.29	172.51	-	-
Past project participation-No	31	91.18	161.61	204.97	-	-
Past project participation-Yes	3	8.82	137.33	198.33	-	-
Loan recipient-No	18	52.94	155.33	223.04	-	-
Loan recipient-Yes	16	47.06	164.13	181.52	-	
Control	14	41.18	63.00	104.73	-	
Treatment	20	58.82	227.00	226.71	-	

Variable: Production Volume (MT per year) - Processors

Covariate	n	n as % of total	Mean (MT)	Standard deviation	>1SD from global mean	Correlation coefficient
-	28	-	344.14	1,308.96	-	-
Province-Battambang	4	14.29	16.23	12.31	-	-
Province-Banteay Meanchey	2	7.14	121.25	86.62	-	-
Province-Kampong Chhnang	4	14.29	1,914.88	3,395.95	X	-
Province-Kampong Thom	5	17.86	137.40	135.67	-	-
Province-Kandal	2	7.14	63.50	51.62	-	-
Province-Phnom Penh	3	10.71	115.00	82.16	-	-
Province-Pursat	1	3.57	73.00	NA	-	-
Province-Siem Reap	5	17.86	67.38	47.95	-	-
Province-Takeo	2	7.14	50.00	-	-	-
Age<30	1	3.57	200.00	NA	-	-
Age ≥30	27	96.43	349.47	1,333.58	-	-
Gender-Female	13	46.43	117.11	151.73	-	-
Gender-Male	15	53.57	540.89	1,787.54	-	-
Past project participation-No	27	96.43	353.55	1,332.93	-	-
Past project participation-Yes	1	3.57	90.00	NA	-	-
Loan recipient-No	15	53.57	550.49	1,788.30	-	-
Loan recipient-Yes	13	46.43	106.04	97.12	-	-
Control	8	28.57	985.81	2,435.03	-	-
Treatment	20	71.43	87.47	87.01	-	-

Variable: Value (KHR per year) - Producers

Covariate	n	n as % of total	Mean (KHR)	Standard deviation	>1SD from global mean	Correlation coefficient
-	1044	-	56,277,354	183,396,258	-	-
Province-Battambang	87	8	33,324,448	84,945,208	-	-
Province-Banteay Meanchey	26	2	12,758,423	12,414,963	-	-
Province-Kampong Cham	119	11	42,205,101	97,035,806	-	-
Province-Kampong Chhnang	120	11	54,588,971	125,934,357	-	-
Province-Kampong Thom	102	10	27,375,433	37,033,381	-	-
Province-Kandal	85	8	58,880,445	66,998,866	-	-
Province-Phnom Penh	39	4	373,828,138	674,475,662	X	-
Province-Pursat	224	21	53,890,754	184,121,823	-	-
Province-Siem Reap	154	15	55,899,310	106,894,500	-	-
Province-Takeo	88	8	10,148,585	15,575,886	-	-
Age<30	40	4	51,846,665	149,605,205	-	-
Age ≥30	1004	96	56,453,875	184,673,877	-	-
Gender-Female	117	11	63,436,468	352,703,088	-	-
Gender-Male	927	89	55,373,776	149,308,579	-	-
Past project participation-No	957	92	59,928,295	190,867,247	-	-
Past project participation-Yes	87	8	16,117,000	34,101,536	-	-
Loan recipient-No	391	37	32,935,254	87,271,624	-	-
Loan recipient-Yes	653	63	70,254,017	220,740,135	-	-
Production type-both	9	1	48,212,222	52,270,659	-	-
Production type-cage	438	42	33,836,967	78,483,635	-	-
Production type-pond	597	57	72,862,740	231,646,608	-	-
Control	293	28	42,486,655	90,996,997	-	-
Treatment	751	72	61,657,746	208,438,963	-	-
Pond area	597	100	-	-	-	0.4705879
Cage volume	438	100	-	-	-	0.4147009

Variable: Value (KHR per year) - Hatcheries

Covariate	n	n as % of total	Mean (KHR)	Standard deviation	>1SD from global mean	Correlation coefficient
-	26	-	393,198	1,175,080	-	-
Province-Battambang	3	12	14,418	6,666	-	-
Province-Kampong Cham	2	8	29,800	39,315	-	-
Province-Kampong Chhnang	1	4	5,958,500	NA	-	-
Province-Kampong Thom	1	4	25,000	NA	-	-
Province-Kandal	2	8	361,250	281,075	-	-
Province-Pursat	2	8	5,457	1,353	-	-
Province-Siem Reap	3	12	425,183	701,509	-	-
Province-Takeo	12	46	177,319	267,597	-	-
Age<30	1	4	25,000	NA	-	-
Age ≥30	25	96	407,926	1,196,859	-	-
Gender-Female	1	4	175,000	NA	-	-
Gender-Male	25	96	401,926	1,198,450	-	-
Past project participation-No	10	38	251,095	387,602	-	-
Past project participation-Yes	16	62	482,012	1,479,640	-	-
Loan recipient-No	13	50	645,956	1,634,089	-	-
Loan recipient-Yes	13	50	140,440	260,815	-	-
Control	15	58	587,255	1,507,972	-	-
Treatment	11	42	128,574	367,348	-	-
Pond area	26	100	-	-	-	-0.198

Variable: Value (KHR per year) - Nurseries

Covariate	n	n as % of total	Mean (KHR)	Standard deviation	>1SD from global mean	Correlation coefficient
-	9	-	214,755,556	535,606,036	-	-
Province-Battambang	2	22	90,500,000	20,506,097	-	-
Province-Kampong Cham	2	22	-	-	-	-
Province-Kampong Thom	1	11	31,000,000	NA	-	-
Province-Kandal	1	11	22,500,000	NA	-	-
Province-Phnom Penh	1	11	45,000,000	NA	-	-
Province-Siem Reap	1	11	1,640,000,000	NA	-	-
Province-Takeo	1	11	13,300,000	NA	-	-
Age<30	2	22	22,150,000	12,515,790	-	-
Age≥30	7	78	269,785,714	605,453,264	-	-
Gender-Female	1	11	45,000,000	NA	-	-
Gender-Male	8	89	235,975,000	568,528,368	-	-
Past project participation-No	8	89	228,475,000	570,893,852	-	-
Past project participation-Yes	1	11	105,000,000	NA	-	-
Loan recipient-No	4	44	50,875,000	37,256,711	-	-
Loan recipient-Yes	5	56	345,860,000	724,130,028	-	-
Control	2	22	17,900,000	6,505,382	-	-
Treatment	7	78	271,000,000	604,882,909	-	-
Pond area	4	44	-	-	-	-
-	9	-	214,755,556	535,606,036	-	-0.357

Variable: Value (KHR per year) - Collectors

Covariate	n	n as % of total	Mean (KHR)	Standard deviation	>1SD from global mean	Correlation coefficient
-	41	-	4,635,034,512,195	29,672,872,632,811	-	-
Province-Battambang	3	7	1,184,000,000	1,676,504,697	-	-
Province-Banteay Meanchey	3	7	282,666,667	159,894,757	-	-
Province-Kampong Cham	1	2	2,180,000,000	NA	-	-
Province-Kampong Chhnang	9	22	74,111,111	74,405,048	-	-
Province-Kampong Thom	6	15	372,000,000	254,804,239	-	-
Province-Kandal	2	5	151,000,000	1,414,214	-	-
Province-Phnom Penh	3	7	4,403,333,333	1,864,841,369	-	-
Province-Pursat	3	7	63,333,804,000,000	109,696,143,537,033	X	-
Province-Siem Reap	1	2	2,590,000,000	NA	-	-
Province-Takeo	10	24	942,200,000	2,481,485,926	-	-
Age<30	3	7	1,132,000,000	1,712,998,249	-	-
Age≥30	38	93	5,000,868,921,053	30,821,925,297,659	-	-
Gender-Female	21	51	949,476,190	1,790,015,743	-	-
Gender-Male	20	49	9,500,823,800,000	42,485,097,704,856	-	-
Past project participation-No	38	93	5,000,953,473,684	30,821,911,212,312	-	-
Past project participation-Yes	3	7	61,000,000	84,870,490	-	-
Loan recipient-No	31	76	835,677,419	1,487,245,740	-	-
Loan recipient-Yes	10	24	19,001,050,900,000	60,082,906,343,715	-	-
Control	21	51	494,809,524	1,721,846,672	-	-
Treatment	20	49	9,501,301,200,000	42,484,985,334,834		

Variable: Value (KHR per year) - Wholesalers

Covariate	n	n as % of total	Mean (KHR)	Standard deviation	>1SD from global mean	correlation coefficient
-	34		1,695,352,941	2,359,737,015	-	-
Province-Battambang	2	6	4,935,000,000	91,923,882	X	-
Province-Banteay Meanchey	1	3	10,900,000,000	NA	X	-
Province-Kampong Cham	4	12	1,935,000,000	1,620,092,590	-	-
Province-Kampong Chhnang	5	15	146,200,000	69,301,515	-	-
Province-Kampong Thom	3	9	2,604,666,667	2,223,138,622	-	-
Province-Kandal	3	9	1,059,666,667	972,075,271	-	-
Province-Phnom Penh	5	15	1,361,800,000	1,942,325,204	-	-
Province-Pursat	4	12	1,807,500,000	2,213,250,475	-	-
Province-Siem Reap	1	3	990,000,000	NA	-	-
Province-Takeo	6	18	396,500,000	534,650,821	-	-
Age≥30	34	100	1,695,352,941	2,359,737,015	-	-
Gender-Female	13	38	2,677,769,231	3,133,541,770	-	-
Gender-Male	21	62	1,087,190,476	1,510,180,374	-	-
Past project participation-No	31	91	1,723,000,000	2,442,483,258	-	-
Past project participation-Yes	3	9	1,409,666,667	1,502,591,206	-	-
Loan recipient-No	18	53	1,592,222,222	2,822,047,203	-	-
Loan recipient-Yes	16	47	1,811,375,000	1,788,143,502	-	-
Control	14	41	449,214,286	615,944,950	-	-
Treatment	20	59	2,567,650,000	2,732,510,784	-	-

Variable: Value (KHR per year) - Processors

Covariate	n	n as % of total	Mean (KHR)	Standard deviation	>1SD from global mean	Correlation coefficient
Province-Battambang	4	14	1,024,000,000	728,081,268	-	-
Province-Banteay Meanchey	2	7	1,990,000,000	1,796,000,000		-
Province-Kampong Chhnang	4	14	8,851,000,000	17,430,000,000	-	-
Province-Kampong Thom	5	18	3,290,000,000	2,834,000,000	-	-
Province-Kandal	2	7	33,600,000,000,000	47,500,000,000,000	-	-
Province-Phnom Penh	3	11	299,333,333	333,522,613	-	-
Province-Pursat	1	4	325,000,000,000,000	NA	X	-
Province-Siem Reap	5	18	622,800,000	684,269,830	-	-
Province-Takeo	2	7	55,000,000	63,639,610	-	-
Age<30	1	4	666,000,000	NA	-	-
Age≥30	27	96	14,530,000,000,000	63,380,000,000,000	-	-
Gender-Female	13	46	5,170,000,000,000	18,640,000,000,000	-	-
Gender-Male	15	54	21,670,000,000,000	83,910,000,000,000	-	-
Past project participation-No	27	96	14,530,000,000,000	63,380,000,000,000	-	-
Past project participation-Yes	1	4	180,000,000	NA	-	-
Loan recipient-No	15	54	4,483,429,600,000	17,350,018,867,405	-	-
Loan recipient-Yes	13	46	25,001,180,000,000	90,138,427,359,233	-	-
Control	8	29	8,404,779,125,000	23,756,859,867,722	-	-
Treatment	20	71	16,251,427,550,000	72,671,873,281,756	-	-

Variable: Cage Yield (kg/m³)

Covariate	n	n as % of total	Mean	Standard deviation	>1SD from global mean	Correlation coefficient
-	440	-	50.30	54.30	-	
Province-Battambang	39	8.86	71.68	75.83	-	
Province-Kampong Chhnang	83	18.86	40.11	39.19	-	
Province-Kampong Thom	51	11.59	65.61	57.37	-	
Province-Kandal	29	6.59	33.34	20.21	-	
Province-Phnom Penh	20	4.55	44.29	44.73	-	
Province-Pursat	161	36.59	47.98	62.77	-	
Province-Siem Reap	57	12.95	54.12	31.77	-	
Age<30	25	5.68	53.98	38.21	-	
Age≥30	415	94.32	50.08	55.15	-	
Gender-Female	39	8.86	38.24	20.84	-	
Gender-Male	401	91.14	51.48	56.39	-	
Past project participation-No	427	97.05	50.24	54.91	-	
Past project participation-Yes	13	2.95	52.24	28.56	-	
Loan recipient-No	117	26.59	46.92	43.70	-	
Loan recipient-Yes	323	73.41	51.53	57.68	-	
Control	112	25.45	38.36	35.30	-	
Treatment	328	74.55	54.38	58.91	-	
Cage volume	440.00	100.00	-	-	-	-0.13236

Variable: Pond Yield (kg/m²)

Covariate	n	n as % of total	Mean	Standard deviation	>1SD from global mean	Correlation coefficient
	596.00	-	5.62	9.86		
Province-Battambang	48.00	8.05	3.17	8.82	-	
Province-Banteay Meanchey	26.00	4.36	1.07	1.41	-	
Province-Kampong Cham	114.00	19.13	4.84	5.24	-	
Province-Kampong Chhnang	38.00	6.38	4.84	4.62	-	
Province-Kampong Thom	51.00	8.56	6.44	5.81	-	
Province-Kandal	54.00	9.06	10.02	9.13	-	
Province-Phnom Penh	19.00	3.19	7.96	8.82	-	
Province-Pursat	61.00	10.23	5.86	6.78	-	
Province-Siem Reap	97.00	16.28	8.43	19.26	-	
Province-Takeo	88.00	14.77	2.70	3.00	-	
Age<30	14.00	2.35	3.36	3.17	-	
Age≥30	582.00	97.65	5.67	9.96	-	
Gender-Female	76.00	12.75	4.72	5.10	-	
Gender-Male	520.00	87.25	5.75	10.37	-	
Past project participation-No	522.00	87.58	6.00	10.21	-	
Past project participation-Yes	74.00	12.42	2.96	6.33	-	
Loan recipient-No	274.00	45.97	4.57	12.66	-	
Loan recipient-Yes	322.00	54.03	6.52	6.50	-	
Control	180.00	30.20	5.35	6.60	-	
Treatment	416.00	69.80	5.74	10.98	-	
Pond area	596.00	100.00	-	-	-	-0.04345

Variable: Pellet Feed Use (frequency)

Covariate	n	n as % of total	N using pellets	Frequency	Mean	Standard deviation	p-value (chi squared test)	chi squared value
-	1204		699	58.0564784	-	-	-	-
Province-Battambang	95	7.890365	74	77.8947368	-	-	<0.001	97.839
Province-Banteay Meanchey	34	2.82392	30	88.2352941	-	-	-	-
Province-Kampong Cham	137	11.37874	72	52.5547445	-	-	-	-
Province-Kampong Chhnang	146	12.12625	58	39.7260274	-	-	-	-
Province-Kampong Thom	109	9.053156	55	50.4587156	-	-	-	-
Province-Kandal	99	8.222591	37	37.3737374	-	-	-	-
Province-Phnom Penh	70	5.813953	46	65.7142857	-	-	-	-
Province-Pursat	245	20.34884	155	63.2653061	-	-	-	-
Province-Siem Reap	162	13.45515	86	53.0864198	-	-	-	-
Province-Takeo	107	8.887043	86	80.3738318	-	-	-	-
Age<30	50	4.152824	31	62	-	-	0.5638	0.33315
Age≥30	1154	95.84718	668	57.8856153	-	-	-	-
Gender-Female	133	11.04651	74	55.6390977	-	-	0.5492	0.35881
Gender-Male	1071	88.95349	625	58.356676	-	-	-	-
Past project participation-No	1108	92.02658	613	55.3249097	-	-	<0.001	42.58
Past project participation-Yes	96	7.973422	86	89.5833333	-	-	-	-
Loan recipient-No	466	38.70432	311	66.7381974	-	-	<0.001	23.532
Loan recipient-Yes	738	61.29568	388	52.5745257	-	-	-	-
Production type-both	9	0.747508	3	33.3333333	-	-	0.004	11.167
Production type-cage	505	41.94352	269	53.2673267	-	-	-	-
Production type-pond	690	57.30897	427	61.884058	-	-	-	-
Control	352	29.23588	181	51.4204545	-	-	0.003	8.9956
Treatment	852	70.76412	518	60.7981221	-	-	-	-

Variable: Top Species Produced (frequency)

Covariate	n	n as % of total	N stocking Pangasius	Frequency	p-value (chi squared test)	chi squared value	Notes
-	1203		392	32.5852037	-	-	
Province-Battambang	95	7.896924	28	29.4736842	<0.001	150.9	
Province-Banteay Meanchey	34	2.826268	13	38.2352941	-	-	
Province-Kampong Cham	137	11.3882	76	55.4744526	-	-	
Province-Kampong Chhnang	146	12.13633	39	26.7123288	-	-	
Province-Kampong Thom	109	9.060682	46	42.2018349	-	-	
Province-Kandal	99	8.229426	18	18.1818182	-	-	
Province-Phnom Penh	70	5.818786	16	22.8571429	-	-	
Province-Pursat	245	20.36575	48	19.5918367	-	-	
Province-Siem Reap	161	13.38321	33	20.4968944	-	-	
Province-Takeo	107	8.894431	75	70.0934579	-	-	
Age<30	50	4.156276	11	22	0.1	2.6609	
Ag≥30	1153	95.84372	381	33.0442324	-	-	
Gender-Female	132	10.97257	52	39.3939394	0.08	3.129	
Gender-Male	1071	89.02743	340	31.7460317	-	-	
Past project participation-No	1107	92.01995	365	32.9719964	0.3	0.94476	
Past project participation-Yes	96	7.98005	27	28.125	-	-	
Loan recipient-No	466	38.73649	209	44.8497854	<0.001	52.085	
Loan recipient-Yes	737	61.26351	183	24.8303935	-	-	
Production type-both	9	0.74813	3	33.3333333	<0.001	223.18	
Production type-cage	505	41.97839	45	8.91089109	-	-	top cage species is Channa striata (45%)
Production type-pond	689	57.27348	344	49.9274311	-	-	
Control	352	29.26018	132	37.5	0.02	5.4716	
Treatment	851	70.73982	260	30.5522914	-	-	

Variable: Most frequent aquaculture management practice reported - not feeding fish with fish waste from harvest

Covariate	n	n as % of total	n adopting practice	Frequency	p-value (chi squared test)	chi squared value
-	1204		792	65.7807309	-	-
Province-Battambang	95	7.890365	43	45.2631579	<0.001	35.002
Province-Banteay Meanchey	34	2.82392	19	55.8823529	-	-
Province-Kampong Cham	137	11.37874	95	69.3430657	-	-
Province-Kampong Chhnang	146	12.12625	104	71.2328767	-	-
Province-Kampong Thom	109	9.053156	84	77.0642202	-	-
Province-Kandal	99	8.222591	64	64.6464646	-	-
Province-Phnom Penh	70	5.813953	41	58.5714286	-	-
Province-Pursat	245	20.34884	152	62.0408163	-	-
Province-Siem Reap	162	13.45515	118	72.8395062	-	-
Province-Takeo	107	8.887043	72	67.2897196	-	-
Age<30	50	4.152824	30	60	0.4	0.77444
Age≥30	1154	95.84718	762	66.0311958	-	-
Gender-Female	133	11.04651	94	70.6766917	0.2	1.5922
Gender-Male	1071	88.95349	698	65.1727358	-	-
Past project participation-No	1108	92.02658	719	64.8916968	0.03	4.8794
Past project participation-Yes	96	7.973422	73	76.0416667	-	-
Loan recipient-No	466	38.70432	308	66.0944206	0.9	0.033234
Loan recipient-Yes	738	61.29568	484	65.5826558	-	-
Production type-both	9	0.747508	9	100	0.002	12.018
Production type-cage	505	41.94352	309	61.1881188	-	-
Production type-pond	690	57.30897	474	68.6956522	-	-
Control	352	29.23588	240	68.1818182	0.3	1.274
Treatment	852	70.76412	552	64.7887324	-	-

Variable: Most frequent post-harvest or business management practice - having a contract or agreement with buyer

Covariate	n	n as % of total		Frequency	p-value (chi squared test)	chi squared value
-	1204		1076	89.3687708	-	-
Province-Battambang	95	7.890365	83	87.3684211	<0.001	145.53
Province-Banteay Meanchey	34	2.82392	25	73.5294118	-	-
Province-Kampong Cham	137	11.37874	108	78.8321168	-	-
Province-Kampong Chhnang	146	12.12625	141	96.5753425	-	-
Province-Kampong Thom	109	9.053156	101	92.6605505	-	-
Province-Kandal	99	8.222591	88	88.8888889	-	-
Province-Phnom Penh	70	5.813953	69	98.5714286	-	-
Province-Pursat	245	20.34884	239	97.5510204	-	-
Province-Siem Reap	162	13.45515	155	95.6790123	-	-
Province-Takeo	107	8.887043	67	62.6168224	-	-
Age<30	50	4.152824	49	98	0.04	4.0904
Age≥30	1154	95.84718	1027	88.9948007	-	-
Gender-Female	133	11.04651	107	80.4511278	<0.001	12.515
Gender-Male	1071	88.95349	969	90.4761905	-	-
Past project participation-No	1108	92.02658	1002	90.433213	<0.001	16.572
Past project participation-Yes	96	7.973422	74	77.0833333	-	-
Loan recipient-No	466	38.70432	385	82.6180258	<0.001	36.466
Loan recipient-Yes	738	61.29568	691	93.6314363	-	-
Production type-both	9	0.747508	8	88.8888889	<0.001	75.287
Production type-cage	505	41.94352	497	98.4158416	-	-
Production type-pond	690	57.30897	571	82.7536232	-	-
Control	352	29.23588	296	84.0909091	<0.001	14.584
Treatment	852	70.76412	780	91.5492958	-	-

Distribution of Propensity Score before and after matching

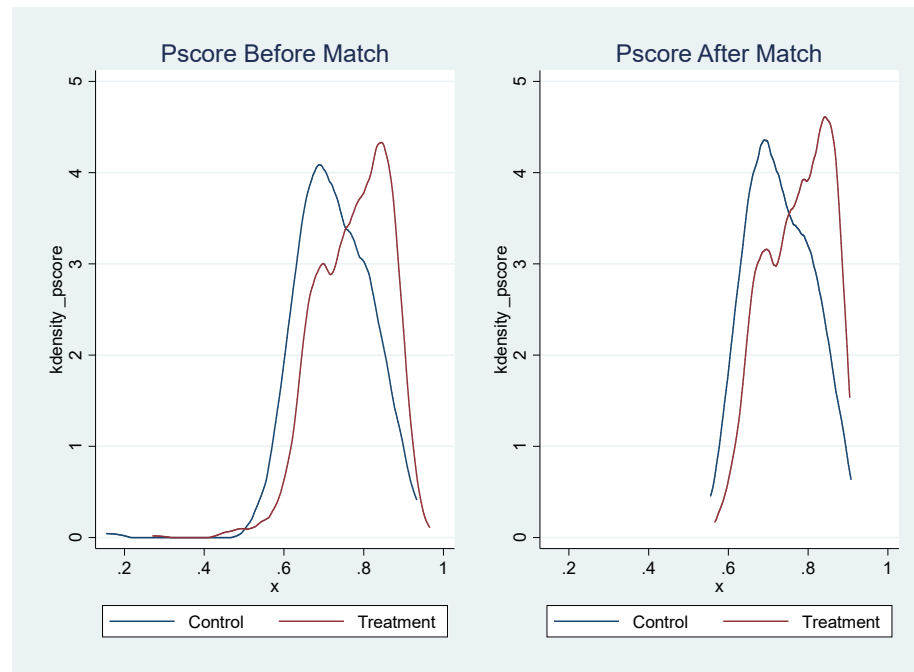


Figure D: Distribution of Propensity Score before and after matching

Table S: List of Un-matched producers (and survey ID) during the PSM analysis

No	Province	ID
1	Phnom Penh	1160
2	Phnom Penh	1164
3	Phnom Penh	1170
4	Phnom Penh	1175
5	Phnom Penh	1183
6	Phnom Penh	1187
7	Phnom Penh	1191
8	Phnom Penh	1200
9	Phnom Penh	1202
10	Phnom Penh	1203
11	Kandal	1161
12	Kandal	1169
13	Kandal	1171
14	Kandal	1177
15	Kandal	1178
16	Kampong Cham	1163
17	Kampong Cham	1190
18	Kampong Cham	1201
19	Kampong Thom	1174
20	Kampong Thom	1193
21	Kampong Thom	1196
22	Kampong Thom	1198
23	Kampong Thom	1204
24	Siem Reap	1173
25	Siem Reap	1176
26	Siem Reap	1180
27	Battambang	1162
28	Battambang	1165
29	Battambang	1166

30	Battambang	1167
31	Battambang	1168
32	Battambang	1172
33	Battambang	1194
34	Battambang	1197
35	Pursat	1179
36	Pursat	1181
37	Pursat	1182
38	Pursat	1184
39	Pursat	1185
40	Pursat	1186
41	Pursat	1188
42	Pursat	1189
43	Pursat	1192
44	Pursat	1195
45	Pursat	1199

Table U: Result of matched and unmatched variables used during the PSM (U: un-matched; M : matched)

Variable	Matched	Treated	Control	%bias	bias	t	p>t	V(C)
age	U	46.724	48.678	-17.8		-2.66	0.008	0.92
	M	46.724	46.231	4.5	74.8	0.96	0.335	1.02
gender	U	0.88671	0.8986	-3.8		-0.56	0.576	.
	M	0.88774	0.91317	-8.2	-113.9	-1.78	0.076	.
loan	U	0.51416	0.33566	36.7		5.34	0	.
	M	0.50515	0.51226	-1.5	96	-0.3	0.767	.

year	U	9.1776	9.5105	-4.2		-0.63	0.527	0.9
	M	8.9301	9.28	-4.4	-5.1	-0.98	0.329	0.97
farmsize	U	3568.9	3600.7	-0.4		-0.05	0.96	2.57*
	M	3045.6	2610.3	5.2	-1269.8	1.39	0.164	2.54*
producttype	U	0.43791	0.36014	15.9		2.33	0.02	.
	M	0.43757	0.48614	-9.9	37.5	-2.04	0.042	.
numbercage	U	0.61111	0.61888	-0.8		-0.13	0.899	0.64*
	M	0.59107	0.66277	-7.5	-822.9	-1.86	0.063	0.93
numberpond	U	0.878	0.87762	0		0.01	0.996	1.46*
	M	0.83505	0.7693	6.7	17514.9	1.44	0.149	1.03
pondsize	U	1539.7	1215.6	7.5		1.06	0.291	1.38*
	M	1292.2	1012.1	6.4	13.6	1.53	0.127	1.18*
male0_14	U	0.14052	0.13636	1		0.14	0.889	1.22*
	M	0.13288	0.11959	3.1	-219.5	0.69	0.49	1.49*
female0_14	U	0.1122	0.07692	9.9		1.42	0.156	1.25*
	M	0.09737	0.08637	3.1	68.8	0.67	0.505	0.88*
male15_29	U	0.56754	0.6049	-4.3		-0.64	0.519	0.89
	M	0.56586	0.55097	1.7	60.1	0.37	0.709	1.01
female15_29	U	0.44989	0.4021	6.7		0.97	0.332	1.13
	M	0.44903	0.42772	3	55.4	0.63	0.526	1.24*
male30	U	1.0458	1.049	-0.7		-0.1	0.921	1.55*

	M	1.0321	1.0231	2	-179.3	0.43	0.669	1.28*
female30	U	0.92484	0.96503	-8.2		-1.2	0.23	1.08
	M	0.91867	0.90103	3.6	56.1	0.77	0.439	1.1
employee	U	0.16122	0.08392	14.4		1.99	0.046	1.73*
	M	0.10309	0.06804	6.5	54.7	1.77	0.076	1.21*

ANNEX H: LIST OF DOCUMENT CONSULTED

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HARVEST Program

Inland Fish Farmers' Inputs & Services Suppliers Guide. 2011

List of villages. Harvest Client in Pursat, Siem Reap, Battambang, Kampong Thom

Harvest Evaluation Data Set

ANNEX I: QUALITATIVE STUDY FINDINGS

A. Aquaculture industry

This topic was explored with a wide range of value chain entities, including development partners, government representatives, Microfinance Institutions (MFIs), Hotels, Restaurants and Caterers (HORECA) and producers, nurseries, hatcheries and post-harvest actors. Within this topic, the researchers investigated two main areas of interest: i) constraints and opportunities to the commercialization of the aquaculture sector, and ii) constraints and opportunities to developing a traceability and quality control system for aquaculture products.

A.1. Constraints to the commercialization of the aquaculture sector

A common theme is the high cost of inputs, such as fingerlings, pellets, medicines/hormones, that affect both producers and hatcheries. The fact that these inputs need to be imported from neighboring countries contributes to their high price on the Cambodian market. The high prices of these inputs leads to increased costs for aquaculture production as well as higher electricity and fuel costs, increasing the overall operational cost of aquaculture production. The high cost of inputs hinders the competitiveness of Cambodian aquaculture products within the domestic market and also for export.

A producer mentioned that: *“In the aquaculture sector, the cost of raising fish is higher than the cost of selling fish on the market”*.

Market price is controlled by middlemen. Producers have limited bargaining power, as mentioned by a CAST partner: *“... they [the middlemen] always make trouble for the fish farmers. [...] from the interview or the survey I did with the snakehead fish farmers, almost 50%, I could say, they had trouble with the market price. Ahead of the harvesting season, and normally before any important function or ceremony, the price is high, but the middleman just lower the market price.”*

A related theme concerns the low market price of imported fish, constraining Cambodian producers' access to the market and reducing their profit margins. This also links to the point about preference for Cambodian produced fish. By raising the profile of local fish, Cambodian producers can begin to differentiate price and not be so beholden to the Vietnamese prices. Market prices are uncertain and fluctuate according to imports. A producer said: *“... the price rate is not stable, it declines when the imported fish from Vietnam enters the market. Because whenever it enters the market, our fish prices decrease.”* This relates to an inadequate institutional framework and capacity, as well as the lack of political will to control imports of aquaculture products. The inadequate institutional framework also affects exports. There is an absence of regulation and procedures to control the quality of fish products for export, and thus to facilitate access to the export market. A development partner says *“...to export fisheries products you need a competent authority, and up to now there is no written document anywhere”*. A feed mill operator mentioned: *“We cannot even adequately supply the domestic market; we need to import aquaculture fish”*.

Aquaculture in Cambodia operates at a low technical level. Respondents described the level of technology and adoption of new technology as low. There is limited capacity to adopt innovations due to the limited capacity of extension services, and the farmers' limited knowledge and risk averseness to adopting new technologies. A processor mentioned: *“Sometimes people are greedy. Their pond can be*

stocked with only 1,000 [fingerlings]. However, they try to stock 3,000 [fingerlings]. So this project will fail if he stocks too much”.

“the lack of quality is because of the knowledge in mixing the diet is still limited. The reason we are still behind is from the quality of our product. When the feed doesn’t meet the standard, fish grow slowly”, explains a feed distributor

Again, this theme is also linked with institutional constraints and the limited capacity of the research and extension services. A government representative mentioned that: *“...laboratory are also very poor regarding fish diseases, water quality analysis. Genetic conservation issues [are] also very poor... These relate to the lack capacity of human resources”.*

Finally, biophysical constraints concern inaccessibility to water and pollution of water resources by agriculture and industry. The months of April and May are difficult for fish farmers, as they often do not have access to water sources. A lack of water and high temperatures increase the occurrence of fish diseases. In addition, the development of industry and the intensification of agriculture now affects aquaculture activities as explained by producer: *“we cannot pump water from our stream. Why so? Because the Chinese spray chemical substances on cassava and rice which flow into the stream. If we are not careful with that water, our fish would die”.*

In addition, fish farmers stock and harvest at the same time due to climate constraints. This results in over-supply of the market, thereby reducing market prices and limiting producers’ bargaining power.

A.2. Opportunities for commercialization of the aquaculture sector

First, respondents perceived that national fish production is far from reaching its potential, given an important domestic market. There is a common belief that Cambodian-farmed fish is of good quality, and is raised using less chemicals compared to imported fish. Often, Cambodian aquaculture fish is ranked second in terms of quality behind wild fish. However, it is a common belief that farmed fish should be sold “live” as an indicator of freshness.

A wholesaler said: *“... The quality of our fish is different from those fish from Vietnam. Our fish is of good quality and would not have any impact on our health. Producers in this village raise their fish in a very hygienic way; I myself also eat these fish”.*

Another wholesaler mentioned: *“Even though we sell our local fish at a higher price, people still buy our fish. Even though imported fish is sold at cheap prices, buyers would not buy it if they knew it was imported”.*

Another opportunity mentioned by respondents is the role of the *Pangasius* in supporting the development of a commercial aquaculture sector. *Pangasius* is considered to be easy to raise, and is popular amongst farmers. In addition, suitable pelleted feed is already available. Respondents mentioned that *Pangasius* can be processed to create different products, and can also be sold un-processed or live. One wholesaler mentioned: *“Do you know why fish retailers love selling Pangasius? Because when they cannot sell all of them, they can process them into various products. They can process Pangasius into fish paste and salted dried [fish]. They only need to dry them in the sun for a while before they can sell those processed fish. They can process it to fermented Pangasius.”* *Pangasius* is seen as a model for the development of commercial fish farming and for industrial processing and export. A feed mill manager explains: *“You know the market demand for process Pangasius is pretty high. So, in the next five years we may see more competition on both quality and price of the fish feed in our aquaculture market and I think we may see larger farms in our country”.*

A.3. Constraints to developing a traceability and quality control system for aquaculture products

Two themes emerge from this topic. First, a theme that covers the limited technical capacity within the sector to enforce a traceability system and the lack of knowledge and awareness amongst aquaculture actors. The second theme concerns the lack of a regulatory framework to enforce an SPS and traceability system.

Several interviewees mentioned that producers lack knowledge regarding both SPS regulation and a traceability system. The lack of basic techniques for raising fish, fish health and food safety creates difficulties for the development and deployment of quality standards. In the post-harvest segments of the value chain, fish collectors and wholesalers are not interested in SPS, as it involves different ways of operating that are not necessarily rewarded with higher price. A CAST partner mentioned that: *“So, even though the producers follow all the good standards of production, when the retailers know the collectors are coming, they don’t really give value. So it means they just give the same price. And then, later on, the producer might think ‘why do I need to do all these complicated things, and then the price is still the same?’”*.

Another barrier is the lack of awareness about food safety amongst most of the poor and rural population of Cambodia, whose first criteria when purchasing fish is the price. In addition, consumers are purchasing live fish, which means good quality, as mentioned by a wholesaler: *“...they [consumers] buy based on the size. Live fish means that fish is good quality. No one questions about fish quality; as long as fish are alive, fat and available in the market, those fishes are good”*. A restaurant manager made mention of SPS regulations: *“Sometimes the laws [guidelines and regulations] have already been established, but we do not understand what’s in them, so it’s more like everything is okay”*.

A development partner said: *“How much people know HACCP⁶⁰ logo? [...] so then there’s no pressure. If the consumers start to go to market and looking for these labels then producers will follow. So we don’t have it, so there is a lack of pressure from consumers”*.

Regulation, and its enforcement, is a key barrier to develop SPS and traceability systems. It appears that a traceability pilot system was developed in 2010 by FiA, but without success, due to a lack of the required capacity to coordinate different actors of the value chain. Also, SPS guidelines were never finalized due to a lack of budget and support from development partners. A government official mentioned: *“We initiated it once in 2010, but there were constraints in making the system work. We lacked technical capacity to make the system. Another problem is that, this traceability system involves various actors, including producers, raw material suppliers, input suppliers, transporters, processors and market distributors. They all need to be recorded in the system, but currently, all these actors aren’t cooperating much. And the thing is that, we haven’t established that system yet”*.

In addition, the roles and responsibilities for monitoring and controlling imported fish products are unclear among government departments, and there are overlapping roles between FiA and the Cambodia Import-Export Inspection and Fraud Repression Directorate-General (CAMControl)⁶¹. A government official also mentioned that: *“Currently, we have some laws and regulations, but they don’t cover all aspects. And the law enforcement is also weak”*.

⁶⁰ Hazard Analysis and Critical Control Point (HACCP)

⁶¹ <https://www.moc.gov.kh/en-us/faqs/catid/3/contentid/11>

A.4. Opportunities to develop a traceability and quality control system for aquaculture products

One emerging theme concerns the need to develop and enforce an SPS system to facilitate the marketing of aquaculture products for both domestic and international markets. Development partners, government officials but also feed distributors and hotel and restaurant representatives share this vision. A development partner mentioned: *“A food safety procedure has to be in place, because we don’t know what chemical products were used in raising this fish”*. HORECA and supermarket managers mentioned that consumers (middle and upper class, foreigners) are more aware of food safety issues. Those actors (e.g., supermarkets and HORECA) do check the quality of the aquaculture products they purchase.

Several respondents mentioned that there is a missed opportunity for producers to access the market and sell at higher prices as consumers cannot identify and distinguish between local and imported products. QR code technology was mentioned by a development partner as a traceability system based on block chain mechanism: *“I think it’s available but nobody really uses that. You know, this is a block chain technology, so it can trace where it came from, how it is processed. In China, I see they use a lot of QR code everywhere”*.

B. Project implementation

B.1. Barriers to program implementation

Input supply

Two main themes emerged: i) local conditions to produce fingerlings, and ii) access to loans.

Access to water for nurseries and hatcheries to produce quality fingerlings emerged as an important constraint, as well as the quality of water. A nursery operator mentioned: *“Another constraint is the irregular rain that makes fish become sick or die [...] it will make the fish die”*. Fingerling production is hindered by the low quality of broodfish available in Cambodia. A hatchery manager mentioned: *“We do not have a place for brood-fish supply which follows proper technical standards”*.

The cost of pelleted feed is high, due to transportation costs. Low-cost feed is often of low quality, affecting the growth and performance of hatcheries and nurseries, as mentioned by a nursery operator: *“If we buy the feed to feed our fish, we might fail because of the lack of protein content in the feed. In Vietnam, they check the quality of fish feed – to check that it contains 30% protein. So the fish will grow fast”*

The second theme concerns access to finance for commercial farms, nurseries and hatcheries. Access to loans from MFIs requires collateral, which is a main barrier to some nurseries and hatcheries in accessing such loans. Instead, they borrow from informal lenders, with high interest rates. This limits investment and growth of the sector. Feed distributors often provide in-kind loans to fish farmers, but they then can face problems in generating sufficient cash flow to run their business until the loan is repaid after harvest: *“Another challenge is that it is hard since some customers owe us, and the debt could get too big – we cannot allow anymore. And we do not have the ability to make exchanges with the company too much, because if we place an order at the company, we have to pay up. That is the main issue”* mentioned one feed distributor.

Producers

Three themes emerged: i) competitiveness between imported and wild fish; ii) access to quality inputs; iii) financial barriers.

Project implementation will face strong competition from imported fish that is low-cost and popular amongst the rural population because of its affordability. Local producers face problems in selling their *Pangasius* due to this competition. A fish farmer said: *“The problem is that a lot of Pangasius remains since there are a lot of imported fish from Vietnam. A lot of imported fish from Vietnam entered [Cambodia] recently, so the local fish prices declined”*.

Due to local conditions, and particularly access to water, local fish farmers sell their product at the same time in the season, which also means that local fish is not available during some parts of the year. This creates a specific market for imported fish.

“Everything that come from neighboring country, they [consumers] tend to feel it’s not good. It is not good or bad but this what people feel, so if we can take this advantage and help consumer to identify which one is from Cambodia, which one come from imported, from Vietnam or Thailand. That would help a lot, even that our price is higher”. (Development partner).

A wholesaler explains: *“Channa striata (Trey Ross) from culture is easy to sell. However, the amount of fish is not enough for supplying in the market since it has its period or season that have no fish to sell. So, I have to buy fish from Phnom Penh which are imported from abroad”*

Wild fish, as the first choice of local consumers, also competes in this market. Consumers prefer wild fish, even if it is more expensive, as they believe its quality is higher than aquaculture fish. A wholesaler: *“People like to consume the wild fish, but the pond cultured fish, they seem not to be interested in buying”*. A nursery owner explains: *“Most people prefer to eat wild fish. They think that the raised fish is not good”*. A producer explains how it affect market prices: *“The price of raised fish per Kilogram must be lower than the wild fish at least 40%. [...] when they [consumers] heard about the cultured fish, they dislike it”*.

Access to quality fingerlings is an issue. Producers order from nurseries or hatcheries they know, and new farmers just copy their neighbors. Nursery or fingerling traders do not have sufficient skills to manage the fingerlings, and there is no certification mechanism, so farmers receive fingerlings of unknown quality. There is also no guarantee that imported fingerlings are of higher quality. As an example, a case from a floating village in Tonle Sap, farmers received snakehead fingerlings from a local trader to stock in their cages in 2019. Three months later, those fish had not grown properly. A cage culture producer explained that: *“When fingerlings traders said that their fingerlings would grow big and well, I would believe them, because I don’t have any test to prove. ...Those fingerlings seemed to be good and to be big. But 3 months after we had released them into the cage, they had only grown to the size of my big toe”*.

Access to feed is also a constraint for producers. Currently, the price of trash fish is high, limiting the development of commercial snakehead farming. A producer explained that: *“In the past there were abundant supplies of fish, but now it has decreased, so if we raise more, the interest rate which applies when we buy trash fish become more expensive. We don’t make much profit from doing that”*.

Local homemade feed used in *Pangasius* culture is of variable quality, with variable protein content. Farmers do not have the skills to produce quality feed, and, with no access to trainings to improve their feed management practices, their feeding practices are of low standards. Finally, snakehead producers must change the water often. A lack of water can be problematic for this type of producer, forcing the farmers to stop their activities in the dry season: *“Regarding to the well pumping from groundwater, we have some ponds for storing water but the source of water is uncertainty for season water usage, the groundwater usage is just in the family scale”*.

Cage farmers also face issues with water quality in the dry season, with anoxic and polluted water due to organic waste or pollution from agriculture pesticides resulting in fish dying in large numbers, as explained by producers:

“... water is also the problem. When we know that the water is not good enough, we move our cage backward or as far as possible. It can be easily contaminated as when the fish from upstream get sick, it makes our fish get sick too.”

“... water which is polluted from the upstream where farmers do their farming. Substance for fertilizer flows into the river, so the water is contaminated”

“...now farmers are doing dry-season rice farming. It flows to nowhere else but into and along the river, so it is hard for us to produce fish”

Access to loans is also an issue for those producers who lack collateral to access loans from MFIs. Also, raising snakehead and *Pangasius* requires a long growing period, even longer than one year, which therefore requires a large investment in feed. Many farmers are facing financial constraints, and so they sell their fish before the fish reach the market size. These factors require producers to borrow cash from informal money lenders at high interest rates. A wholesaler mentioned: *“The fish producers don’t have enough money to raise the fish – [specifically] regarding the expenditure on the feed. For example, the people who live nearby the river who raise Channa micropeltes - if they have low a budget, they can’t raise the fish well”*. A cage culture producer mentioned: *“I really want to expand my business, but I don’t have money, my capital is not enough. People living on the river are poor, they can earn just enough for daily living”*.

Post-harvest

Emerging themes for this segment of the value chain concern i) the competitiveness between imported and wild fish; ii) the availability of local products, and iii) the lack of access to international markets.

Imported fish influence local market prices, making local aquaculture products difficult to sell. At the same time, wild fish command higher market prices. *“There is nothing [more] important [than] just making sure [that the] price rate is stable - don’t make it decline when the imported fish from Vietnam enters the market. Because whenever it enters the market, our fish price will decrease”* says a fish producer.

Those constraints limit opportunities for collectors, wholesalers and processors to support and promote local aquaculture fish. The high price of local aquaculture product is reflected in the final price of processed fish products. Low-priced processed products are imported, and these compete with local processed product. Processors express this as:

“the local fish is more expensive than the one from other country”

“just make sure make price rate stable don’t make it decline when the imported fish from Vietnam enters the market. Because whenever it enters the market, our fish price will decrease.”

The supply of local aquaculture fish is seasonal, affecting the activities of post-harvest actors. *“If we talk about fish raising in Cambodia, Channa striata from culture is easy to sell. However, the amount of fish is not enough to supply the market since there are periods or seasons when there are no fish to sell”* mentioned a wholesaler.

The quality of locally-produced fish is not homogenous. Fish in some farms are fed improperly/insufficiently, leading to poor quality product that doesn’t meet the local market’s requirement. A wholesaler reports: *“Some producers cannot afford to feed their fish, so the fish become so skinny”*.

Interviewees mentioned that the market requirements and volumes for export do not exist. In addition, the procedures and guidelines for export do not exist. The case of a private company who wanted to export

Pangasius fillets but never reached the quality and quantity requirements illustrates this issue, according to one wholesaler and one producer: *“I used to hear that someone was preparing processed fish to export overseas. It was so difficult when taking the fish to the port. They had to choose fish that did not have any imperfection or damage. If fish were found to have any minor blemishes, then those fish will be removed. ... This is a thing that we cannot do.”*

The processing sector is also limited by the lack of local capacity. The sector remains “family based”, with limited investment, equipment, and technical capacity. *“Local fish processors cannot access information about the export market as their knowledge, capacity and networks are very limited. They are not so interested in the export market since they believe that it involves very complicated procedures and processes”.*

Barriers to project implementation mirror the general constraints within the aquaculture industry, with import of low-price fish causing market issues, limited access to quality inputs, and low capacity of the support system, producers and post-harvest actors.

B.2. Facilitators to program implementation

We disaggregated the analysis of facilitators to program implementation for i) input supply and producers, and iii) post-harvest actors.

Input supply and producers

A common theme with several interviewees in the input supply segment was the need for a more formal network and communication channels, that could be facilitated by the widespread adoption of communication technology in rural areas. As mentioned earlier, in Cambodia there is no formal network for sharing market information. Actors, especially producers and collectors, use their own connections for accessing market information. A development partner explained: *“I think in general, this producer they [actors of the value chain] are not really well connected, at least to other stakeholders. They are connected mainly to their well immediate stakeholders. For example, if you’re aquaculture, a farmer, you are connected to your buyer, your middle man, and also to those who supply your inputs. ...it’s not that well-connected in terms of producers – the farmer, to the consumer, the farmer to the farmer. I think that’s not that well-connected, especially between farmer and farmer”.*

Smartphone technology can be used for better linkages between producers and other market actors. Furthermore, this technology can serve as a platform for facilitating other information sharing as well. For example, people in the sector can use it for sharing experiences, sharing good practices and for sharing new technologies. A feed distributor explained how he uses his smartphone to access and share information : *“... I can access a smartphone and the internet. I can search for all the information that I need such as prices and sources of products. I can also call suppliers and customers from my phone if I need to.”*

Better transparency of information is a good step in developing better trust in the value chain, which contributes to lowering overheads, and raising profits.

A second emerging theme concerns the local capacity of specific actors of the value chain - and specifically the hatcheries that acquire technical skills through trial and error, making them good candidates to be lead farmers and a source of knowledge. A hatchery owner mentioned: *“Yet I still wonder*

how they (Vietnamese fish farmers) can raise the fish to grow well but we can't? So I had to try it by myself. Passion has pushed me to raise more fish."

A nursery operator mentioned: *"For everything, if we take good care of it, it won't fail. Like my husband and I, when we started to deliver for the first time, a lot of fingerlings died. But I sought strategies which can save fingerlings and reduce the fingerlings' mortality rate"*.

Feed distributors who started their business with limited aquaculture knowledge also gained experience through their engagement in the sector over a longer period of time. As a result, some feed distributors became unofficial learning hubs for producers. For example, one feed distributor and fingerlings producer mentioned that his strategy for attracting more clients was to share a complete set of techniques on aquaculture to provide support to farmers, alongside selling fish feed and other aquaculture inputs: *"I used the strategy that I have mentioned [...] we would bring the complete set (technical support, fish health, and fish feed) along with fingerlings to producers"*.

A feed distributor explains: *"Before I sell the products to farmers I always ask them about problems or issues that they are facing, and then I provide the technical guiding with the specifics products to farmers."* A nursery manager describe : *"I guide the fish farmers about the way to make water system or we process the feed from food waste (kitchen) as fish feed"*.

This type of actor could become a central point for sharing such information, especially to medium-scale producers, who mentioned that they do not get any training or support from any source . For producers, other farmers remain the main source of knowledge. A producer said: *"In general, the fellow fish farmers shall share the information to one another. For example, when I had good medicine, I would share to other farmers whose fish had diseases to apply the good medicine, since I had experience before"*. This topic shows that existing and emerging network of producers and input suppliers can be the base on which to build more formal networks within the value chain.

Post-harvest

As for producers, an emerging theme mentioned by processors and wholesalers is the presence of an existing network that can be the base for future, more formal organization of the sector. Currently, connection between actors are informal. For example, a fish processor indicated that he processes fish based on orders placed by his clients: *"The market is not the problem. For example, when we purchase at a higher price, I then have to ask customers to pay a higher price, because the fish is more expensive now when they come to buy from me. Once we agree on the pricing, I will start processing the fish. I cannot start doing it if there is no agreement with customers to increase the price, otherwise I won't make any profit. Overall, they follow the market. A shortage of fish at the market forces me to increase the price."*

Likewise, a wholesaler stressed that he has no problem selling his fish, as every day his clients also place orders, so he knows how much fish he should collect from each producer each day: *"Today, if the customer orders 2 tons, we will catch 2 tons. If the customer orders 3 tons, we will catch 3 tons."* The CAST project may be able to help to strengthen these networks, and also to introduce new technologies for better communication in order to achieve better linkages between business owners and their respective clients.

Another theme, less frequently reported, road and transportation networks that have improved greatly over the last 15 years. Fish collectors, wholesalers and processors all have sufficient transportation capacity, although refrigerated trucks are not common.

“The transportation is more comfortable than before, the road is easier to access, we transport fish faster than before, we can go from this market to that market, smoked fish won’t get damaged” express a processor.

Project facilitators in the different segments of the aquaculture value chain are limited to the existing network that can be used to upgrade the performance of the sector. The interviews did not identify specific technical or market related facilitator(s).

C. Services and support needed for beneficiaries’ success

The first theme that emerged is the need for better coordination and access to information and knowledge for different actors of the value chain. This idea is expressed by the need to create an association or platform that supports information exchange. The majority of those whose main livelihood activity is aquaculture indicated that they have never received any proper training and/or support from any development project at all. When talking about acquiring updated technologies, these producers want a proper information channel which provides them with regular support. Producers mentioned:

“I want to have frequent training and want them [CAST project] to show me which medicine to treat fish, teach me to diagnose fish and provide medicine that can treat our fish.”

“I want to gain experiences and techniques like yours, which include methods to raise fish, to treat sick fish, to use medicine and so on”

In relation to this, some farmers indicated that it would be helpful to have an aquaculture association in place so that they can use this association as a platform for regularly sharing experiences amongst members, as mentioned by a feed distributor: *“I want to have a relationship with other retailers to gain more experience from them. For example, we can share with each other about our knowledge and experiences so that we can learn from each other and all gain knowledge together.”*

Some suggested that the CAST project could create an online hub of technologies which each member can access anytime, as it already exists in other sectors. This last point was expressed by a feed distributor: *“Nowadays farmers also know how to use modern technology. When we get information, we distribute it through WhatsApp. Everyone can get the information because now the cell phone technology is used by everyone, even when the animal is sick, they just take picture and send it to us to check”*.

A second theme, related to the previous theme, is the need to develop a domestic value chain to limit the negative impact of imported fish on local fish market prices. A CAST partner mentioned:

Having more transparent access to market prices would help. *“You can see somebody offers this price, you see somebody offers that price, you can make comparison. This is a real thing”* a development partner mentioned. A processor also mentioned: *“If the organization tells us the price of fish for one kilogram, and we can gain more profit, we follow the organization.”*

Access to loans with lower interest rates to finance aquaculture activities was frequently referred to. This topic was already mentioned as a barrier to the project and a constraint to the aquaculture industry. Banks and MFIs perceive the sector as risky, exacerbated by a lack of access to information about the sector. Therefore, their investment in this sector is limited. Fish farmers, especially those who live in floating villages, take loans from private money lenders. They have to pay back both the principal and interest at the end of the production cycle (harvest and sale). A producer said: *“Right now, we can take loans from certain clients. For example, we may be able to take a loan for the sum of 2,000 to 3,000 USD;*

but when harvesting and selling the fish, we have to pay it back. The total interest is more than the principal that we borrowed.

“If you don’t take a loan, you can sell your fish for 8,000 (riel) per kilogram; however, if you take a loan, you have to sell the fish to your creditor, and the price of your fish is only 7,000 (riel) per kilogram. You can see that we lose 1,000 riel per kilogram. So, you have to work hard to not become a borrower so that you can sell your fish at a higher price”.

Access to quality fish feed would facilitate beneficiaries success. All respondents insisted that the price of commercial fish feed for *Pangasius*, and the price of trash fish for snakehead, are both relatively high compared to the prices of these inputs in neighboring countries. Respondents also discussed the lessons learned from past projects and what they consider a useful approach to engage actors of the value chain. A CAST partner mentioned that the project should support the development of a niche market for quality fish, stimulating the demand for higher value fish: *“if we convince the restaurants and the hotels to really purchase those good quality (fish) compared to the normal one, I think it might also be an option that we can increase the demand for the producers, specifically those who adopt specific good practices”.*

Service and support to value chain actors needs to follow a systematic approach, and provide support within technical, economic and institutional dimensions. As such, increasing profitability and developing business models for producers is required to improve access to loans, to increase market prices by developing a niche market and to create a demand for high-quality fish. This can be achieved by different means and using different tools.

D. Relationship building

We identified two main themes related to relationship building: i) the need for an aquaculture association; ii) improved trust and connection between actors.

D.1. Aquaculture association and private advisors

Actors highlighted the need to have a formal platform to share information among the various actors of the value chain. In the aquaculture sector there are informal networks currently operating at national and provincial level. However there are no formalized/official networks to help support better horizontal and vertical coordination of the value chain, or play an advocacy role. A development partner explained: *“I think in general, producers are not really well connected, at least to other stakeholders. They are connected mainly to their immediate stakeholders. For example, if you are aquaculture, a farmer, you are connected to your buyer, your middle man, and also to those who supply your inputs. ...it’s not that well-connected in terms of producers – the farmer, to the consumer, the farmer to the farmer.”*

An aquaculture association should promote local aquaculture production in responding to market demands and help producers gain reasonable profits from product upgrade. An association should play a role in coordinating and supporting traceability and SPS systems and should involve different actors. A CAST partner stated:

“I think, CAST has to form like a team from, similar to association, but they have to involve the producers, middlemen, retailers, private sectors, and people from the university, the people from maybe FIA, the people from Ministry of Agriculture, Forestry and Fisheries, and probably from Ministry of Commerce so they all understand about the purpose of CAST because they’re not only producing but they also want to have the certification, production certification”.

The project should build on previous experience in the agricultural sector; upgrading value chain functioning, small-business and the emergence of a commercial sector. A development partner mentioned about an online tool: *"...it connects the banks, the input suppliers, the buyers. It's almost like a supply chain finance/management system. So everyone's on one system, everything is, you know, transparent and digital. And it makes decision making easier, just sort of a general business operation. They, as I said, they've been working in rice, and I think that they had some success in rice"*

Feed mills, feed distributors, hatcheries, nurseries, hotels and restaurants, are interested in the development of an association because it would facilitate information transparency, and sharing among actors. Fish producers are keen to see an association play a role in providing both aquaculture technical guidelines and information about market demand and updated market prices, sources of quality seed, feed and medicine. A restaurant owner sees the association as a "control" system related to quality standard: *"When they [producers] join the association, they will gain more knowledge on how to raise the fish properly, so it won't affect the health of the customer. If they are not under control of the association, they can do whatever they want with the fish by feeding it with chemical substance to make it grow abnormally"*

FiA officers recognize that the extension services provided by the government are inadequate, and that the government needs the private sector, associations and NGOs to fill these gaps - for example, by transferring aquaculture technology, promoting local aquaculture products and supporting SPS and traceability systems. This already exists to a certain extent. A feed distributor involved in fish raising explains the services he provides: *"I have my own fish farm. We provide fingerlings to fish farmers, extension service such as supplying both technical support and fish feed. We also provide fish's healthcare services, thus the number of producers increase as they can harvest more yield."*

However, this type of service supplier is limited and there are limitations in the amount of advisors supporting fish raising techniques. Trust issues also exist when the same people both provide technical support and sell inputs.

D.2. Trust and distrust between actors

Long-term relationships between clients and service providers are common in the aquaculture sector. The development of trusted relationships can take different forms: providing technical recommendations when purchasing inputs (feed, fingerlings) or a technical follow-up of a client's production. Other trusted relationships exist in the form of 'business partnerships' between feed suppliers and fish producers, producers and fish collectors, and feed mills and feed distributors.

"I trust the middleman. We do business together for almost two decades. For example: when the truck arrives, the middleman calls me [...]. I go and collect that fingerlings from them and share with my fellow farmers" a producer explained. Another producer explained about collectors: *"They are our loyal client, we do not concern that they are going to cheat us. Even with money, no need to fear."*

"I've been doing fingerling business for 15 years in here. For the old customers who take the fingerlings from me, they don't run off although my price of fingerlings is a bit expensive, they still buy fingerlings from me because they trust me that I never cheat them." a hatchery owner explains

Those relationships are based on trust between parties. We have seen that long-term relationships, personal connections and networks are really important in the aquaculture value chain. However, this trust can be jeopardized. Distrust of input suppliers can hinder adoption of new technologies or practices. For instance, some producers did not receive good quality fingerlings from fingerling traders as illustrated by a statement of a fish producer: *"In Phnom Penh, there are some places that sell fingerlings too, but those*

places might cheat the farmers". Commercial fish feeds may not yet have received an approval or certificate from the government. These issues can be the result of a lack of regulatory framework or inadequate enforcement, as mentioned by a feed mill manager:

"We do not know exactly whether all of the commercial feed in our market has received approval from the government agency who is responsible for this or not. As a result, many farmers do not trust the feed quality".

"These days when fingerlings traders said their fingerlings would grow big and good, I would believe them because I don't have any test to prove. Once they said it's good, both you and I would agree that it is good. When we first saw them, they are big but 3 months after we release them into the cage, they grow to the size of my big toe only"

Fixing trust issues and improving connections between actors is essential to developing and expanding commercial aquaculture in Cambodia. It relates to the previously identified theme and the use of online tools to facilitate interaction between actors increase transparency for price and economic return. This also applies to MFIs and their need to better understand the sector.