AQUACULTURE SURVEY IN PERU AND FEASIBILITY STUDY

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PALGEY MAIM AQUACULTURE AND WATER ENGINEERING COMPANY, ISRAEL

FINAL REPORT PRESENTED TO THE MINISTER OF PRODUCTION PERU
DATE: 05.04.2017

PALGEY MAIM

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EXECUTIVE SUMMARY

The Aquaculture Study Survey in Peru was initiated by the interest of the Minister of Production of Peru to investigate objectively the current situation of the Aquaculture industry in the country in order to evaluate what could be done to increase annual production significantly.

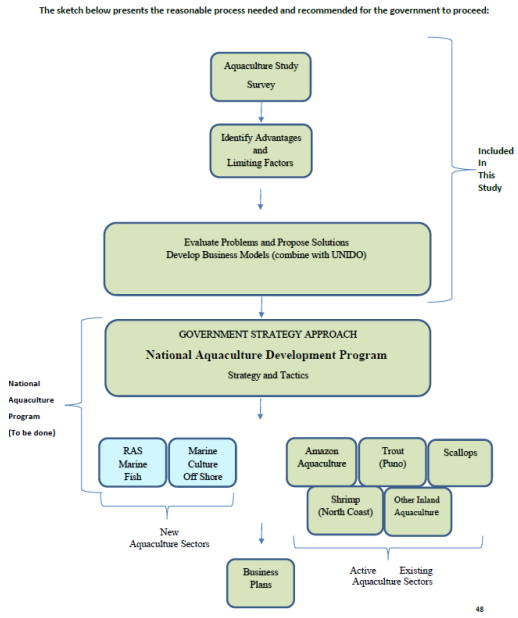
The approach of the investigation was to cover as much area in Peru as possible during the two weeks allocated for the study and to observe, learn and evaluate limiting factors from one side and relative advantages on the other.

The information to be collected from the field should help to identify strengths and weakness of the aquaculture industry in Peru. This should surface sectoral and national problems in order to bring to the Government' attention and consideration optional solutions and approaches towards an action plan and program for the upcoming aquaculture development in Peru.

The study was divided into two parts.

The first part was the field trips and visits in representative aquaculture regions, sectors and research institutes in Peru.

The second part was to process and analyze the information, evaluate the relevant options for the potential growth of the aquaculture industry and to present our recommendations to the Government how to proceed with potential investment and promotions wisely in order to make a significant impact on aquaculture with the limitation of the means and abilities allocated to reach National aquaculture production targets in Peru.



We introduced a concept scheme which is presented here on the right (see p. 49 details)

We covered the Tilapia and Freshwater prawns farming and research institutes in Tarapoto, the Amazon fish farming and institutes in the area near Iquitos, the scallops farms and institutes on the coast, shrimp on the north west near Ecuador and the trout cage farms in Lake Titicaca.
We have identified limiting factors and proposed options to improve production on existing sectors in addition to proposed new sectors of Marine culture and recirculation Aquaculture Systems on the coast for marine fish species. We have suggested business model of central – satellite farming concept to consider by the Government.
We have included in the study concept structure to proceed with strategies and tactics including implementing Action Items to follow after the study.
The main outputs of the study are concentrated in the final conclusion and recommendations regarding allocating funds and achieving the targeted aquaculture production increase which is the focal point of the study.
The final chapter concludes the action plan accordingly with our main suggestions to the Government:

1. Form an National Aquaculture Committee which will be responsible for the following:
    a. Prepare a National Aquaculture Program with advice to the Minister on the Strategy:
        i. Aquaculture Sectors to promote and invest
        ii. Regions to develop
        iii. Species to develop
        iv. How to invest the funds for the best "cost vs. benefits" results and based on business plans
2. Define the allocated Budget for the National Aquaculture Program
3. Define the mechanism, set the rules and regulations how to invest the Government' funds in the Program
4. Execute the National Aquaculture Development Program

General:

With the cooperation of The Peruvian Ministry of Production team and coordination with UNIDO, and after organizing the mission and identified the regions in which the aquaculture survey will be carried out in Peru Ramy Alon, Aquaculture Biologist of Palgey Maim Water and Aquaculture Engineering Company, arrived to Lima Peru on Sunday, 5th March, 2017 and started the work according to the pre-planned program schedule.
Please note that this final Aquaculture Study/Survey document is based on information collected before, and during, the study in Peru between 5th-17th March 2017, on publications, meetings with Government authority's representatives, extension agents, producers, investors and other stake holders in the aquaculture industry in Peru. The Study/Survey is considered as professional advices and recommendations document to the Ministry of Production of Peru from our expert's team with many years of experience in the biology, technology, research, water, and civil engineering of global aquaculture.
This Study/Survey is based on the proposal to the Minister of Production of Peru dated January 26, 2017.

SURVEY VISITS DETAILS and CONSIDERATIONS

The Study concluded 12 days in Peru with 4 international flights, 7 domestic flights and a long road travel along the coast North of Lima. In every region we travelled by car and by feet to remote places with no access roads were aquaculture activities take places. The following places covered during the study are indicated on the map below:

Picture 1: Study Travel map. The numbers represent the days and places visited during the travel in Peru

Day 1: 6/3/17: Lima

Meeting with Ministry of Production:

Mr. Jorge Zuzunaga, Director General del Aquaculture
Ing. Lorenzo Mina Valdivia, Viceministerio de Pesca y Acuicultura DGA (Dirección General de Acuicultura)
Ing. Joaquin Razetto de la Puente, Asesor del Despacho Ministerial
Ing. Alex Cerna ¿?, Viceministerio de Pesca y Acuicultura - DGA
Ing. Juan Canturin ¿?, Viceministerio de Pesca y Acuicultura - DGA

The meeting "kicked off" the Survey/Study in Peru by Ramy Alon Aquaculture Consultant and the Engineering team Ran Weisman and Amos Dank from Palgey Maim Aquaculture and Water Engineering Company in Israel.

The meeting started with orientation of the study program. The following issues were discussed and considered:

1. The Minister of Production of Peru has requested the study in order in investigate objectively the current situation of major aquaculture sectors in the country. The target of

the study is to understand better the relative advantages on one side, and the limiting factors on the other side, in order to prepare and act towards the national targeted intention to increase aquaculture production in the near future according to the Ministry expectations (from 97,000 MT in 2016 to 200,000 MT in 2017/18, or as soon as possible).

2. The Study will also investigate sustainability and profitability potential and their limitations in order to identify restricting reasons which may be improved and solved in order to attract new investors into the aquaculture industry and to increase production of existing farms.
3. The Study will evaluate the options within different existing and new aquaculture sectors to diversify and introduce modern technologies, new fish species and improved culture protocols to increase overall production.
4. Threats of banning Peru scallops exportation to France were mentioned as an issue to consider.
5. Preliminary evaluation for potential Marine culture concessions were presented by the ministry aquaculture directors on the National aquaculture operations map of Peru.
6. Orientation of the detailed Study/Survey program (see table below) was concluded.

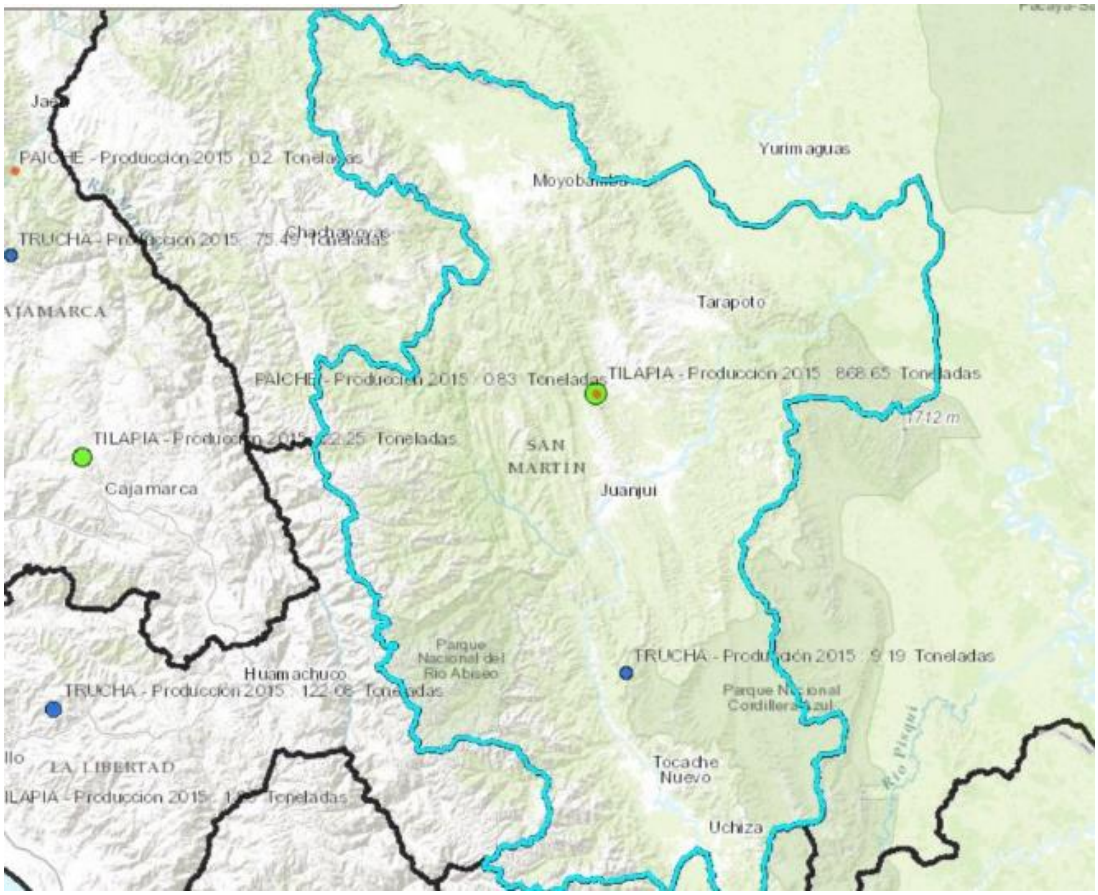
AQUACULTURE STUDE/SUVEY PROGRM FOR RAMY ALON IN PERU

Fecha	Actividad	Hora	Lugar	Participantes
Domingo 05	Llegada a Lima		Lima	
Lunes 06	✓ Reunión DVPA ✓ Reunión DM ✓ Visita a IMARPE ✓ Vuelo a Tarapoto	10:00-12:00 12:30- 14:30 15:30-17:00 19:45 LAN	Lima Callao Callao	 Alex Cerna
Martes 07	✓ Visita a productores de Tarapoto ✓ Visita CITE Acuícola Ahuashiyacu ✓ Vuelo a Iquitos	08:30-11:00 11:30-12:30 16:40 STAR	Tarapoto Tarapoto	Alex Cerna
Miércoles 08	✓ Visita al IIAP ✓ Visita a Amazon Harvest ✓ Visita Empresa Sr. Wenseslao Sol Sol ✓ Retorno a Lima	08:30-10:00 10:30-12:30 15:00-16:00 20:10 LAN	Iquitos-Nauta Iquitos- Nauta Iquitos -Nauta Iquitos -Nauta	Alex Cerna
Jueves 09	✓ Salida hacia Huaura ✓ Visita ACUAHUAURA ✓ Visita a Pacific Deep Frozen ✓ Desplazamiento a Casma	07:00 10:00-11:00 14:30-16:00	 Huaura Huarmey Casma	Alex Cerna Gladys Rocha
Viernes 10	✓ Visita a ACUAPESCA ✓ Visita Centro La Arena FONDEPES ✓ Visita Planta de ACUAPESCA ✓ Retorno a Lima	08:30-10:00 10:30-11:30 12:00-13:30 20:00	Huaynuma – Casma La Arena – Casma Lima	Alex Cerna Gladys Rocha
Sábado 11	✓ Trabajo en Lima ✓ Descanso			
Domingo 12	✓ Descanso ✓ Vuelo a Tumbes	 18:59 LAN	Lima Tumbes	Lorenzo Mina
Lunes 13	✓ Visita a MARINASOL ✓ Visita Lab Larvas MARINASOL ✓ Visita Laboratorio IMARPE ✓ Retorno a Lima	08:00-13:00 15:00-16:30 21:29 LAN	Tumbes Tumbes	Lorenzo Mina Elie Barsimantov

Martes 14	✓ Viaje a Juliaca ✓ Visita Laboratorio IMARPE ✓ Visita a planta Piscifactoría Los Andes	10:45 LAN 14:30-16:00 16:30-17:30	Chucuito – Puno	Juan Canturin
Miércoles 15	✓ Visita a Piscifactoría Los Andes ✓ Retorno a Lima	08:00-10:00 21:30 LAN	Chucuito – Puno	Juan Canturin
Jueves 16	✓ Visita UCSUR ✓ Reunión de trabajo con integrantes de la Mesa Acuícola ✓ Reunión DVPA	09:00-10:00 11:00-12:00 12:00-12:30	Lima Lima	C. Berger

Regions covered during the Study/Survey and Considerations:

Day 2: 7/3/17: San Martin, Tarapoto:



Picture 2: Map of San Martin, between the Andes and the Amazon Jungles of North East Peru

Visits in Tarapoto and San Martin

1. **Visit CITE** (http://www.itp.gob.pe/nuestros-cite/cite-publicos/item/172-cite-pesquero-amazonico-ahuashiyacu) **Center Innovation Technology for Aquaculture including fish processing and R&D facilities (both under final construction phases).**
    - The processing plant will be able to train and also to process local fish at small-moderate quantities. The facilities of the plant are built according to global standards with quality control measures and HACCP capabilities including QC lab.
    - The R&D center which is located next to the research open ponds and small feed mill (2,500 kg/hour) in the premises will host researchers in aquaculture and generate knowledge and information which will service local freshwater fish and giant fresh water prawns (*Macrobrachium rosembergii*) farmers in the region.

CITE Tarapoto Tilapia breeding ponds

Picture 3: Top right: Tilapia breeding ponds. Top left: R&D facilities under construction. Bottom left: feed mill

Discussions with CITE Projects managers and local feed mill manager revealed the following information:

- Tilapia spawning and fingerlings production in the center are not always providing satisfactory results in "all males" tilapia off springs. Not sure about the reasons for this. However, In addition to practical considerations the quality of brood stock should be further investigated and measures to avoid brood stock management should be adapted.
- Recently, there is an increase in the exposure of tilapia to specific deadly gill parasite called *oodinium* (https://en.wikipedia.org/wiki/Oodinium). Conventional treatments are not always effective resulting in fish and brood stock mortalities.
- The costs of fish meal is high compared to other places in the world even though Peru is number 1 fish meal producer in the world. Vegetable protein is imported from US and overall tilapia fish feed production (with 28% protein content) in the local tilapia fish feed mill is about $1.00/kg. For comparison, this price is about 30% higher than the price in Israel!
- The local feed mill has an interest to produce and sell tilapia feed to local tilapia farmers and in the past there were attempts to finance and/or give credit to fish farmers. The demand was small and now this program has stopped. The feed mill is working under optimum capacity at the moment and external demand is small.

a. **Problems identified:**	Poor sex reversal results
a. **Solutions to consider:**	Improve brood stock genetic material, mismanagement of brood stock and evaluate sex reverse protocols
a. **How to implement:**	- Introduce new GIFT and Chitralada strains brood stock from US and Thailand and ND 59 and other improved tilapia strains from Israel. Brazil also has good improved and adapted tilapia strains. - Prepare program and implement "Genetic Improvement Program" of Tilapia Brood Stock in Peru (as part of National Aquaculture Program) - Improve sex reverse protocols and applications by staff and -management
b. **Problem identified:**	*oodinium* gill parasite
b. **Solutions to consider:**	Treatment with Cooper sulfate
b. **How to implement:**	Use protocol on web site: http://edis.ifas.ufl.edu/fa008
c. **Problems identified:**	Costs of Tilapia feed ingredients and production costs end up with high feed costs to the end customer, the fish farmer.
c. **Solutions to consider:**	Need more investigation beyond this study how to reduce feed costs in Peru. This study was not able to determine reasonable true reasons for this dilemma and to suggest solutions.
c. **How to implement:**	Government should proceed with in-depth investigation in order to find out where the limiting factors are, who is controlling the market, and what can be done to reduce raw material costs for fish food production in Peru, especially of

fish meal. Alternatives of lower price fish feed importation from Brazil should be considered.

2. Tilapia Farms in San Martin

Visited a new tilapia private hatchery now under construction, owned by Mr. Carlos Anches.

Picture 4: Construction 2 reservoir ponds which will supply water to the Tilapia nursing ponds with green water

Visited a small scale (under 30 Tons) private Tilapia fish farm owned by Mr. Mardin Penhefo.

Picture 5: Series of extensive tilapia ponds fed by gravity flow water from the main canal in the San Martin High lands

In San Martin there are numerous small scale tilapia farms similar to the one shown in picture 4 above ("formals" and "informal") and the investigation of this sector in this part of the Amazon should be further extended by the Ministry beyond the scope of this study. However, we examined these cases studies and treated them as a "representatives" for the Tilapia sector in the region since they were the only tilapia farms operations on the program. Therefore, before adapting our recommendations for this sector, the Government should confirm our findings and approve our assumptions regarding this covered area in the current study as "representative" of the whole San Martin region. The following issues were considered during the survey:

Problems to consider:

a. **Problem identified: Sex Reverse of Tilapia is poor, resulting in high percentage of females:** This is a common problem in the Tilapia industry and it affects the farmers in the following ways:
    i. Females don't grow to market size, or grow very slow.
    ii. Females start wild spawning early (after 3 months) in the culture ponds and contaminate the ponds with mixed sex fingerlings (males and females) which are difficult to manage and culture commercially. Some ponds are not built with complete draining option making this problem almost impossible to control.
    iii. Small fingerlings of wild spawns escape easily from the farm in the effluent water and contaminate other fish farms downstream.
    iv. Overall result for the farmer: more money is spent to feed fish which do not grow to market size. The farmers buy "all male" fingerlings from the suppliers and end up with high percentage of females (which don't grow), therefore, pays for more fingerlings than needed. Example: The farmer need

4 fish of 250g to sell 1.0 kg of fish. Usually, it would take about 5-6 fingerling (mortality considered) in order to get 1.0 kg. However, with the current situation the farmer may need 10 or more fingerlings to get to 1.0 kg of fish!!

b. <u>Solutions to consider:</u>

ii. Check the sex reversal protocols of the supplier hatcheries and correct.

iii. Check the execution of the protocols, they may be correct (perhaps the workers are either incompetent, or are not trained properly, or maybe the sex reverse hormone is weak or old or not kept in storage properly, or maybe other reasons to investigate and point out).

iv. Develop (Government, or private, or PPP) one or two main hatcheries with good quality control and quality assurance with Government regulations and supervisions which will supply good quality stocking fingerlings to local tilapia farms.

v. Train individual farmers to produce fingerlings in their own farms. The technology is simple and inexpensive even for small farmers.

vi. Introduce carnivorous fish ("police fish") to eat wild spawned fingerlings (this is done successfully in Israel with Red Drum fish (*Sciaenops ocellatus*).

vii. Introduce cage farming system in natural and manmade (dams) lakes and lagoons – The breeding cycle of tilapia is disrupted in cages. Tilapia can be cultured at high densities in cages that maintain free circulation of water. Excellent results are evident in Costa Rica, Panama, Mexico, Honduras, Nicaragua, Colombia and Brazil

viii. Introduce **"Central Farm – Satellite farms"** fish farming model (will be discussed later on p. 13) which will enable to guarantee quality fingerlings among other things.

c. <u>How to implement:</u>

i. Gov. should Demand QC (Quality Control) and QA (Quality Assurance) certification from commercial registered hatcheries.

ii. Certified commercial hatcheries must comply and provide performance records to Gov. for tractability which will be published to the public.

iii. Commercial hatcheries will have to keep internal data records and "after sales" tracking records to enable authorities to inspect results at the customer's end.

iv. Gov. Agents will train the hatcheries managers and employees in the hatcheries and will supervise performances based on sex reversal results after sales.

v. Gov. Agents will train small and medium size farm managers and employees modern, yet simple, techniques to breed tilapia in their farms: Brood stock spawn in hapas, eggs collected from the mouth and hatched in incubators, then, transferred to sex reversal simple tanks under full controllable

conditions. Gov. Agents first will go through hatcheries trainers' course according to Gov. Chosen protocol (this program is called: **"training of the trainers"**).

vi. Gov. will select and recommend optional carnivorous fish (native species preferred) to be used as "police fish" and application protocols (ratio, size, etc.). According to Dr. Christian Berger, years ago at IMARPE-Iquitos, now IIAP, they worked with a native species *Cichla ocellaris,* "tucunare", "peacock bass, as "police fish". Young "paiches" were also found to be effective.

Note: Palgey Main Company can provide training courses for breeding and sex reversing of tilapia, as well as supplying improved Tilapia fish Genetic material for breeding upon demand.

d. Problem identified: Tilapia Farmers grow small fish to the local market: Local market in San Martin demands small fish (200g-250g) which is not optimal for the fish farmers due to the growth curve of Tilapia. The farmer would increase both production and profitability if the market size will increase above 500g (best economical results will be about 1.0 kg under local temperature and natural conditions). In addition, growing bigger tilapia require less fingerlings for the same results (2-3 fish/kg instead of 6-7 fish/kg!).

Note: This problem is also directly related to logistics problems of marketing Tilapia fish out of the Amazon region; there are no roads from this area to the coastal areas enabling transportation of Tilapia products to other markets in Peru which may be able to consume more tilapia products from the Amazon and demand bigger fish. No processing plant is currently available locally to enable added value products manufacturing. In addition, there is no human grade ice available in Tarapoto and elsewhere in the tropical area of the Amazon.

a. Solutions to consider:

i. Marketing efforts are needed to introduce larger size fish to local niche markets (Restaurants, Hotels, others) in the near region.

ii. Local processing plant is needed to operate and provide processing services including ice generation machies and insolated containers for transport chilled and live fish.

iii. Introduce to the local market "Added Value" products such as tilapia fillets, fish nuggets and other products obtained from big size tilapia (see picture p. 10).

iv. Increase production of Tilapia fish in the region and enable exporting fresh fillets to US and export markets as well as to coastal regions (especially Lima).

e. How to Implement:

i. Consider to Construct and build Government' or private processing plant locally (within about one hour drive from local fish farms) which will process and value add to the fish products. This processing plant factory (or more) will have marketing power on the different markets in terms of volume and abilities to supply continuous produce. These factories will be able to reduce

air freight costs of fresh tilapia products to Lima and the coastal regions and compete.

ii. Government should consider to finance advertising and publicity of **National Tilapia products** (and even label them as **"National Peru Tilapia"** for example) in order to differentiate between local fresh (and frozen) **quality tilapia product** and **Chinese lower quality** frozen tilapia imports. This can be done faster, on TV shows, internet adds, newspapers, billboards, fine restaurants and famous Chefs' promotions and other publications, and slower, through market education.

Note: Importation of frozen Tilapia products from the Far East are not only lower in quality. In addition, imports tilapia frozen fillets are glazed with high percentage of ice and the true comparison with fresh product is "hidden" from the average customer.

Picture 6: Wong Supermarket Fish Department San Isidro, Lima

See the difference in the prices (in Peruvian currency Soles) of fresh large size Tilapia fillets on the top and small fresh whole Tilapia fish on the left. Pictures taken from **Wong** Supermarket in Lima, Peru on 12.03.17

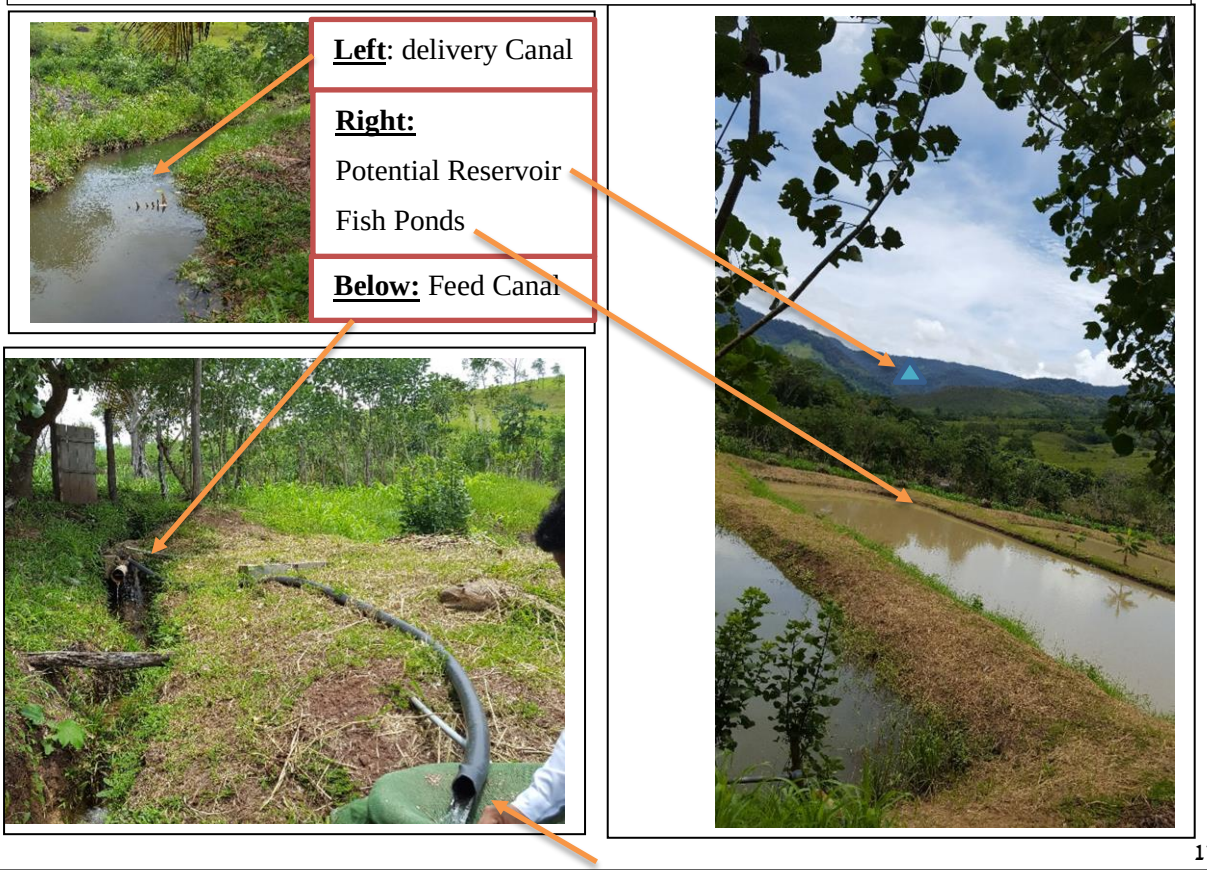
San Martin
Farmed Tilapia

iii. Government should consider subsidizing local tilapia production and/or exportation of tilapia produce by paying some kind of "bonus" to the fish farmers for their "registered" fish produced, and/or exported products. This is common in other countries for the sake of substitute and reduce importation to the country. This will also increase the voluntary "informal" farmers which are currently unregistered to become "formal" registered legal farms.

iv. In the past attempts were made in Tumbes to use aerators with diesel motors. It was complicated and unsuccessful, only when electricity was available and economically affordable, mechanical aeration was used successfully. Similar considerations are true for Tarapoto and other tropical regions.

C. **Problem identified:** limitation of water during the dry season (4 months between Augusts to December). Water shortage and high temperatures are limiting tilapia fish production during the dry season and even cause fish mortalities (due to oxygen depletion) resulting in heavy losses of income to farmers. In addition, the study in the area of San Martin exposed poor water channeling and delivering systems to the individual fish farms (see picture 6 below). There is little, or even, no monitoring and control over the water use by individual farmers. Due to poor piping system a lot of water is lost on the way to the fish farm from the main delivery canal. Fish farms do not control their effluent water and fish (especially from wild spawn) escape downstream and contaminate fish farms with wild spawned tilapia fry and other uncontrolled fish.

Picture 7: Water distribution canals are limited and even not available year round



The farmer is trying to block invading fish fry from upstream fish farm with screens on his water inlet

C. **Solutions to consider**

i. Improving water resources by **"water catchment"** during the rainy season using **dams.** Then, diversion of water from the new water reservoirs by gravity flow to the farm. The reservoirs main target is to hold ("storage") water to be used during the dry season. Note: Underground water is not an option due to its known acidity and low alkalinity.

ii. Improve water flow and distribution system (canals) in order to enable more water flow and water exchange in the fish ponds. Authorities will monitor and control the water use by the individual farms and regulate water use.

iii. Consider Government (with small deductible to the individual farmer) to provide **fish insurance** against natural phenomenon, such as water shortage, oxygen depletion, predation, diseases and more (this type of insurance is working in Israel).

iv. Introduce the use of mechanical aeration to fish ponds in order to maintain oxygen supply at all time. This addition of aeration (paddle wheels or similar) together with improved water exchange from reservoirs will enable to increase fish densities in the fish pond up to 20 MT per hectare (in Israel even more under similar conditions) and increase overall annual production in this sector significantly

2. How to implement:

i. Gov. Project: identify topographical areas which can be dammed in order to catch and hold water during the dry season. In these Amazon "highlands" there is no threat for migration of natural fish in their natural habitats. Design and engineer dams and reservoirs. Build dams and reservoirs and improve channeling the water to fish farms.

ii. Note: our Company Palgey Maim https://www.youtube.com/watch?v=k21y9KqmvjY specializes in these kinds of projects and solutions and will be able to propose the most suitable engineering solutions options to generate and supply water for this sector upon Government' request. This project(s) could be part of a General Government **Aquaculture National Program**.

iii. Our environmental engineers reviewed the region on Google Earth and catastroacuicola maps http://catastroacuicola.produce.gob.pe/web/ and identified potential options to catch and hold water during the dry season. In order to evaluate further the options to catch, distribute, and deliver the water to the fish farms the following are recommendations and suggestion to the Government:

a. Consider our recommendations for the engineering concept and principle to catch and hold water year round and supply to the fish farms in the region of San Martin.

b. Request from Palgey Maim Company a proposal for the engineering work needed to prepare for this project. Following, Palgey Maim will prepare the engineering planning proposal accordingly. Please take into consideration that Palgey Maim Company can also execute this project in San Martin on a basis of "turnkey project" (or to supervise local contract work) and will be able to submit such proposal on Government' request as well.

D. Additional Problems identified:

i. Fish feed costs are more expensive in Peru, including San Martin, than everywhere else we know. Farmers also complain about high costs to lease more farming space of water and land suitable for fish farming in San Martin.

D. Solutions to consider and how to implement:

i. Build and operate Government' owned (or PPP) local feed mills for reasonable feed prices.
ii. Import fish feed from Brazil (less expensive providing logistics and importation taxes are considered by the Government).
iii. Further investigation is needed from the Government to find out the relevant (direct and indirect) reasons for this problem, other than logistics.
iv. Government evaluate and attend to the lack of financing to the small and medium size farmers in the region and/or organize reasonable farming loans and other reasonable financing.

Overall Structure Problem:

The general structure of Tilapia fish farming in San Martin is based on opportunistic entrepreneurs, mainly small and medium size fish farmers who own, or lease, land and combine basic fish farming techniques with small or medium size agriculture activities on their lands. The farmers collect or divert water by small pipes and canals with low efficiency and high maintenance needs. The farmers are exposed to high risks and questionable profitability challenges. They are not organized well and do not possess either buying or selling powers and therefore, are exposed to economic risks with little ability resist and improve their condition.

Suggested Concept Structure Solutions:

Introduce Central – Satellite farms model structure (option. See below concept sketch):

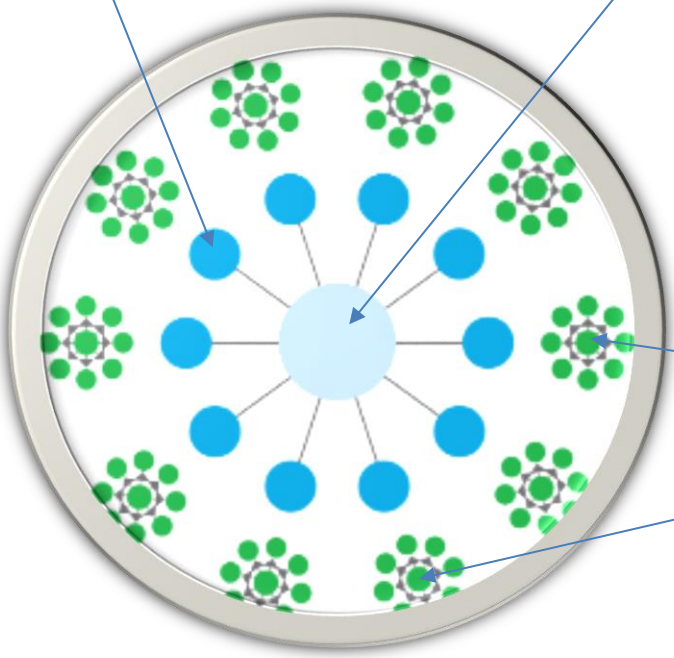
Central Farm – Satellite Farms (CF-SF) Model

Central Farm (500 Ton or more)

- Hatchery (breeding)
- Nursery (grow fingerlings)
- Production Units (cages ponds)
- Training Fishermen
- Feed Supply
- Technical services
- Veterinary Service
- Logistics
- Equipment renting
- Harvesting service
- Packaging & processing
- Marketing and Sales
- Consulting

Satellite Farms

- Fish ponds on land (minimum 30 Ton)
- Growing Fish to market size
- Selling to CF or independently



Expanding CF-SF Model to other locations in the country

Introduction:

The area of interest (Amazon highlands and lowlands) has great potential and capacity for aquaculture development above and beyond current production today. The options for aquaculture development in general, and the specific tilapia farming potential, are based on this conceptual model specifically recommended for this part of the country where unique limiting factors exist as indicated above. The proposed concept model presented here will be further defined, studied and evaluated according to sites specifications and environmental conditions. This will be done after Government' request which is beyond the scope of this survey study in Peru (see Proposed step 1 below). This concept is to be approved by the Government as part of the **Strategic Aquaculture Program** suggested in the final part of this study.

The general idea is to introduce an alternative to small scale individual farmers who can no longer make their living off the traditional farming activities in the region. First stage is to build a **Central Sustainable Fish Farm** which will support and provide services to **Satellite small fish farms** around it. The project and the concept of **Central Fish Farm and Satellite Fish Farms** is called **Central-Satellite Model (or CF-SF).**

Concept Model:

The Central Farm (CF) is a sustainable fish farm which has all the facilities to stand on its own especially with regards to raw material (fingerlings) production on one side, and marketing abilities and power on the other.

The CF includes the following facilities and services abilities:

- Hatchery (breeding)
- Nursery (grow fingerlings)
- Production Units (cages or ponds)
- Training and education culture techniques
- Feed Supply
- Technical services
- Veterinary Service
- Logistics (vessels)
- Equipment renting
- Harvesting service
- Packaging & processing
- Marketing and Sales
- Consulting

The Satellite Farm (SF) includes the following facilities and abilities:

- Fish Production units
- Operating equipment and personnel
- Production capacity to supply product according to production and harvesting plan.

Suggested Financial Model (this is an optional and other financing options should be further considered with the Government):

The central farm (CF) will be budgeted and financed like any other investment based on a detailed Business Plan which will reflect ROI, profitability, cash flow and sensitivity analysis. The capital investment and operating costs will be funded by the Government's choice (Government owned, PPP, bank loans and guaranties by the Government to private investors, National or International funds, etc.). The Satellite Farms (SF) will be budgeted similarly by a financial model suitable for the investor (either Government or Private). The general concept is to reduce private fish farmer's investments and risks by providing them with comfortable loans and even starting with special grants or other financing in order to "push" them to join the project. The model will evaluate the option to finance the small farmers from initial fish stocking in their ponds until they are able to sell the fish through the Central Farm program. The details of this scheme will be provided in a separate document upon Government request and following the proposed order once the Government has approved it (option).

The CF will manage the overall administration and financial of the project (both CF and SF) and will plan production and sales (for both CF and SF) according to the major marketing plan of the whole cooperation and program. This model enables buying power of feed and other inputs and selling power capabilities by allowing and introducing big quantities of Tilapia products to local and export markets. The major benefit is the ability to organize the products and process the fish locally, and then to ship them under quality control measures out of the isolated Amazon region (special attention should be also given to export fresh tilapia fillets to the neighboring Brazil despite of the obvious logistics limitations). The advantage for the individual farmer is the short term growth and lower risks (the small farmer, SF, will concentrate on the culture of 5-10g, or more, fish instead of hatching size which will reduce about 2 months of culture and risks).

Proposed Steps to follow based on Government' interest to adapt and proceed with the CF-SF model:

1. Conduct specific Aquaculture Survey/Study in the Amazon region aimed to locate the most suitable location for the suggested model, followed by detailed Feasibility Study (which is beyond this preliminary study) including:
    a. Travel of experts (aquaculturists and engineers) for a trip to the region. (Government official's aquaculture experts should join this mission).
    b. Data collection from the pre-defined potential sites and potential markets.
    c. Prepare and submit detailed feasibility study for the suggested model with the following:
        i. Preliminary estimated CAPEX
        ii. Production Plan
        iii. Preliminary estimated production costs per kg fish produced
        iv. Preliminary concept design (engineering outline of the technology)
2. Prepare Business Plan and general engineering plans for the suggested model.
    a. Full Business Plan ready to submit to banks and financial institutes.
    b. Advanced engineering planning (general engineering) including all facilities of the project.
3. Detailed Engineering Plans
    a. Detailed engineering plans for building and construction of the project.
    b. Bill of Quantity (BOQ) all materials and equipment, including imported items and local works.

4. Pilot project –optional (also known as Model farm or Demonstration farm)
    a. Design and build a demo unit which will be installed on site as a model for the project. This may be one or more fish farming units or ponds on land. The exact definition of the model and its characteristics and therefore, technological specs will be concluded during the detailed feasibility study (1st stage above). A budget for the model will be based on the target the Government or other owners wish to achieve and based on the following considerations:
        i. Proof of concept
        ii. Economical sustainability and ability to pay itself back.
        iii. Other considerations

- Palgey Maim Company will submit (upon Gov. request) a separate detailed proposal based on the Government choice to the above concept' proposal (proposed steps for above 1-4 points).

Freshwater Pawns (*M. rosenbergii*) in San Martin

Visited small farm manager: Jose Carlos Gastelo

Problems identified:

Water shortage – same as above

Expensive feed **–** same as above

Finance – no available aquaculture loans for small producers

More considerations: Need a comprehensive Business Plan for private small and medium size feed mills in the region.

Frozen processed farmed prawn product

M. rosenbergii larval culture tanks

Picture 8: Larvae culture tanks on Right and Frozen processed Prawn on Left

Discussion and considerations *M. rosenbergii* in San Martin

The sector of freshwater prawn in San Martin is small and only 4 small farms are known to cultivate small commercial quantities of product to the local markets. Knowhow and management seem to master culture technique and breeding and no longer limiting factors in this region. However, the logistics and water limitations, just like with the Tilapia sector, are considered limiting and restriction this sector to grow. Therefore, we suggest to consider freshwater farming in this region the same way as we did for tilapia (see above considerations, conclusions and suggestions including Business Model).

Day 3: 8/3/17, Iquitos:

Picture 9: Google Earth Map Iquitos and vicinity

Visited IIAP R&D (http://www.iiap.org.pe/ El Instituto de Investigaciones de la ***Amazonía Peruana***) and saw presentation on Amazon fish R&D activities during the last 10 years and then visited R&D facilities. All activities and structures looks professional with excellent hatching results of most Amazon fish studied in the center. Master and Bachelor students are actively working in the wet labs and reproduction and developing the needed knowhow to develop aquaculture techniques in the field. Culture protocols are available to be used and transformed to local fish farmers and interesting parties.
Managers complained about lack of funds lately due to stop oil pumping in the region.
More research is needed to spawn Amazon fish year round. Now spawning in captivity has increased from 4 to 9 months.

Things to consider and recommendations:

- Need to evaluate new potential Amazon fish, for example, one excellent candidate is the Amazon shovelnose catfish (*Pseudoplatystoma*) see below picture.

Picture 10: Amazon shovelnose catfish (*Pseudoplatystoma*)

- The remote Amazon region presents serious logistics problem especially with lack of transportation for goods and products. Fish processing plant is under construction and will be ready in July (need to confirm status and schedule).
- Selling Arapaima (Paiche) fingerlings to South East Asia - Exportation of live Amazon fish will probably be reduced and restricted by the Government' regulations! This issue should be further evaluated according to its benefits to the industry. We suggest to the Government to call for a "round table" discussion on this subject together with the producers and to regulate according to the overall well-being of the sustainable aquaculture industry in the region as well as other Government' relevant considerations including local social aspects.
- We also suggest to consider hatching and nursing Amazon fish (especially Paiche) in the region and then, grow out to market size in the coastal area (where the markets are) to reduce transportation and production costs. This will also expose the Amazon fish products to the coastal area where consumers currently do not demand it commercially as they do with marine fish. Fish can also be grown under RAS conditions in the coastal areas. We recommend to the Government to generate a comprehensive Business Plan (BP) for this scheme (will be further discussed in the final report).

  Note: Palgey Maim Company is able to propose such Business Plan to the Government. The company has vast experience with preparation of "bankable documents" to national and international financial institutes.
- Farmers can't get reasonable loans for aquaculture (now 24% interest!! Should be reduced below 9% with at least 16 months grace). Gov. should look for such financial schemes.

Visited 2 Arapaima Fish Farms (Amazon Harvest and Fundo Tony)

General Observations and Complains regarding limiting factors:
Both Complained about lack of financing and logistics.
High energy costs, high feed costs.
No local market out of the near markets in the region. In the big cities no demand for Amazon fish.
No veterinary service for diagnostics and fish pathology. No local labs. No fish health assistance locally/

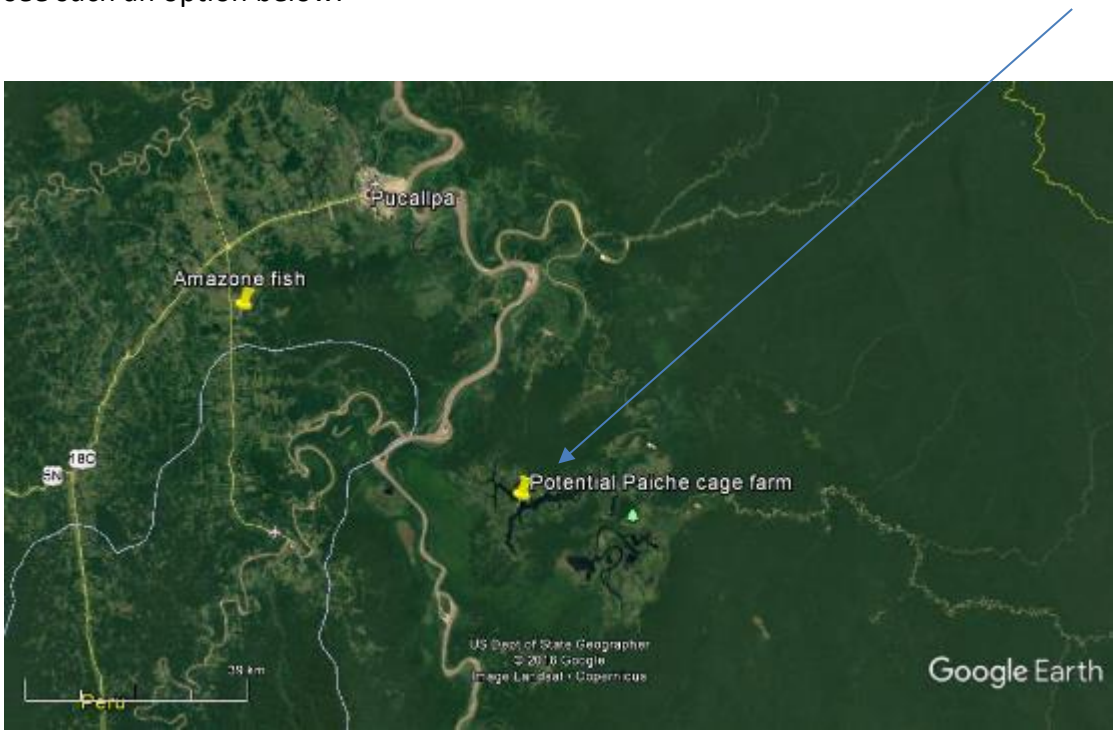
Observed Paiche (Arapaima fish) cage culture and open ponds culture in Amazon Harvest. Government and private should further evaluate cage culture in lakes and lagoons in the region.
No large size pelleted fish food for Arapaima. Maximum 30mm. The fish need up to 60mm size pellets.
Oodinium (gill parasite) seems to be a real invasive problem. Need to investigate and recommend proper treatment protocol for all species based on restricting regulations.

Private Amazon (Arapaima) growers:

- Need to increase reproduction results
- Reduce FCR (now 1:2,1:3)
- Reduce feed costs (bring from Manaus or look for other solutions – High priority issue!)
- No large size commercial feed is available for Paiche (need 60mm and now bigger size pellet is 30mm).
- *Oodinium* gill parasite seems to be a problem lately with culture Paiche. Treatments and regulations should be considered to battle with this disease agent and maintain control over fish health condition and the environment (see Tilapia section above).
- No reasonable financing available for small and mid-size farmers.

All farmers in the region, according to locals, culture and sell together about 50 ton/month to local/national/export markets.
New Processing plant will be ready in July 2017 in Iquitos. 1.5 sol per kg costs to process Arapaima in the new processing plant (this price for processing should be confirmed).
Another area where Amazon fish are cultured is near Pucallpa (see map below). Both regions of Iquitos and Pucallpa should be further investigated in order to locate ideal aquaculture areas for production, mainly cage culture in lakes and lagoons.
Recommendations and applications:
Regarding effective increase of production beyond the considerations above we recommend to explore the option to introduce Paiche farming and other native Amazon species in cages in lagoons and lakes with suitable conditions. The Paiche fish can be grown in the region under intensive conditions in lakes and the knowhow of reproduction is well under control. Breeding is done in ponds with little involvement of the farmer. Off springs are sheltered and protected by the female and then transferred to nursery on land for short time and then to the cages where they grow fast to market size.

We at Palgey Maim recommend the Government to conduct a survey to locate such lakes with suitable conditions especially for Arapaima cage culture but also for other Amazon species. Following Government interest to pursue this option we shall prepare a proposal accordingly. Please see such an option below:



Picture 11: Google Earth map of Pucallpa and vicinity

Note: One important issue to consider for the Amazon fish especially Arapaima (Paiche) is the fact that there are unknown "informal" number of Amazon fish farmers (mainly small) which are not registered and their production activities are not published.
The following notes were brought up by local aquaculture and industrial people interested in the development of this region in Iquitos and Pucallpa. Among them we use some quotations from Mr. Alvaro Agurto Mazzini from Asesoria Comercio y Marketing, Mr. Italo Solimano and Mr. Alberto Vasquez from Amazon Harvest and Fundo Tony below:

Picture 12: Business Cards of people whom we met and discussed "Paiche" issues

Quotations of above persons cited during the Study:

1. **Quote: "Need construction of a process plant with national and international certification".**
2. **SANIPES CERTIFICATION AND CUSTOMS:**
   "If there were customs and SANIPES operating services in the Region, it could be exported directly from the region, significantly reducing the costs and the operation that is centralized in Callao, both for air and sea freight".
3. **NEED TO SPEED UP AND CHANGE THE FUNCTIONS OF THE REGIONAL REGULATIONS**
   "Changes in the way of obtaining the CITES certification (CITES = The Convention on International Trade in Endangered Species of Wild Fauna and Flora) for export and in the collections and forms for the national marketing.
   Reduction of paperwork and costs for obtaining certificates (TUPA - the Single Text of Administrative Procedures).
   Effective control of illegal and clandestine sales and closure periods (October to February) which is not respected, thus avoiding the sale of products of poor sanitary quality in Peruvian markets. What also means a detriment to serious business activity that complies with standards and pays costs"?
4. **SANIPES**
   "Need Regional office with the capacity to oversee and control the regulated aquaculture activity; as well as the international quality of the production of Paiche meat (norms and control of heavy metals and / or prohibited antibiotics)".
   5**. FINANCING**
   "Need Access to credits of low interest rates that allow financing the activity of fattening the Paiche that requires of high working capital".
   6. **IIAP and UNIVERSITIES**
   "Need to encourage the development of research in nutrition, genetics and reproduction of the species, as well as post-harvest and supply chain management".
7. **PROMOTION**
   In order to increase the market of Paiche it is required institutional support so that the Peruvians know the benefits of their meat; as well as for its promotion abroad, as it was done with the pisco in the embassies of Peru abroad".
   Create the National Day of Paiche in the Peruvian Amazon.
   The Paiche should be promoted in the meetings, cocktails and dinners of the Embassies of Peru abroad.

Above quotations of local producers and distributers claimed that if these points are developed and carried out, productive chains could be made for the economic development of the region that so badly needs it

Day 4: 9/3/17, Coastal Area Casma Region

Picture 13: Google Earth Map Casma and Vicinity

1. Visited **ACUAHUAURA** Tilapia farm about 200 km north of Lima on the coast of the Pacific. Tilapia fish are cultured here in earth ponds with plastic liner under greenhouse structures. The culture method is **"bio flock"** system which is based on activated suspended particle (organic matter) and heavy aeration. Densities are high, up to 50 kg per meter cube with very little fresh water exchange. Culture technique seems to be working with good biological and fish performances results and the fish look very healthy and strong in this system. However, energy costs are high and return of the investment is questionable. In addition, the farm is not able to pump water from the nearby sea which should have been considered relative advantage. This is due to limiting regulations of pumping water from the sea. (Note: This issue is repeating often in this study and should be evaluated from all regulatory and adequate ecological considerations. It seems that there is work to be done in this restricting issue to enable more water for aquaculture in coastal region with the suitable balance between aquaculture needs and environmental considerations. The use of water from the sea is mainly an issue of the quality during the return (effluent) water after their use for aquaculture and not before, the way it was presented to us during the study.

Major issue!: Importation of low cost frozen tilapia fillets from China caused reducing in the farm production from 180 MT (Metric Tons annually) since about 2 years ago, to 80 MT last year! The profitability of this fish farm is under serious threats and the owners must consider the options.

Note: The farm is selling fish above 500g to local markets in Lima. This proves that with good accessibility tilapia culture in the Amazon region can participate in this market share subject to other relevant considerations.

Mainly the need to differentiate fresh quality tilapia products (mainly fillets) from low quality importation (see San Martin chapter above).

Picture 14: Tilapia indoor greenhouse farm under "Bio-Flock" Culture technology (ACUAHUAURA Tilapia farm)

Consideration and recommendations for this Tilapia Farm:

a) To different their Tilapia products as "labeled" premium quality - Introduce Tilapia fresh fillets to local markets (especially in Lima) and sell it as high quality fresh premium product ("Peruvian pride") different from low quality frozen importation
b) Owners should consider to convert the farm from Tilapia to marine shrimp farm (*Penaeus vannamei)*. This organism is capable to be cultured under the existing "Bio Flock" conditions at up to 10 kg per m^3 and under the local environmental conditions can be cultured 3-4 cycles per year (to 20g). Market evaluation and comparisons with existing costs and benefits should be done in order to confirm such economical advantage this suggested option.
   Note: Palgey Maim is able to provide consulting and prepare full business plan documents as well as everything else needed to convert the farm to Shrimp Farm. We will submit a proposal upon such request.
2. Visited **Pacific Deep Frozen** Flat Fish (*Paralichthys desperss)* Hatchery and Grow out Pilot Farm on the coast about 300 km north of Lima.

The operation consists of hatchery and nursery facilities on one side and grow out fish tanks on the other side. They pump about 100 m^3/hr. sea water and disinfect wit UV.
Currently produce 6 Ton fish per year. The farm has 50 Ton production capacity per year. Water temperature 15-21 degrees C (extreme conditions can elevate to 24 during El Niño).
The fish grows slow and reach market size of 500g in 18-24 months. Wholesale market price is 50 Sol/kg. Food Conversion (FCR) is 1:1.5. They produce their own feed of 50-55% protein.

<u>Picture 15:</u> Pacific Deep Frozen Flat Fish (*Paralichthys desperss)* Hatchery and Grow out Pilot Farm

Problems to address:

- Limited local markets for flat fish
- Need more research and development. Mostly is done with their own private money and effort and "not enough by the Government" (according to the grower's quotations).

Considerations

- The operation looks like a modern R&D center more than a commercial fish farm and its capacity is well equipped to obtain more fish production than it does now. If water is a limiting factor this issue should be the first to consider and solve. The use of more sea water should be further evaluate from regulatory and environmental considerations by the Government.

  <u>Note:</u> Palgey Maim Company has vast knowledge and experience in the treatment of the effluent water from marine fish farms located near the coast and discharging water to the sea. We have designed effluent water treatment plants from marine fish farms with strict environmental regulations especially for organic waste, ammonia and minerals, complying with Government' requests in Israel.

Day 5: 10/3/17, Coastal Area Casma Region
Aquapesca Scallops Farm and Processing Plant

Picture 16: Google Earth Map of Tortuga Bay where Aquapesca and Fondepes are located

General:

Peruvian scallops production has dropped in the last two years, due to climatic changes and El Nino. Higher temperatures on the back of El Nino increased water temperatures causing mortalities of scallops this year. Algae blooms also increase the mortality rate. Big mortalities are caused as well by flooding carrying suspended materials, as we have seen in the recent "El Niño Costero" event. Prices change according to production levels and lack of reliable larvae which may affect both production quantities and prices. France is generally the largest buyer of Peruvian scallops.

The majority of production is produced by small and medium-scale farmers in central and northern Peru. The ban placed on fresh chilled scallops imported from Peru by the European Union in 2008 has not yet been lifted, so only frozen scallops are exported from Peru. A good overview of the current situation of this sector is found on the Seafood Trade Intelligence Portal website: http://www.seafood-tip.com/sourcing-intelligence/countries/peru/scallops/

The Aquapesca Company was founded in 1989.

Operated until 2014 with one hatchery. The farm produced until then 1,200 MT scallops per year.

During 2016 started working with 2 hatcheries on site. The farm now produces 1,550 MT scallops per year.

Target is to increase production to 2,000 MT per year.

The company has 2 more scallops farms in the North coast of Peru.

Challenges:

- Need more concession sites to grow more scallops.
- Need more seawater for the hatchery and this is difficult to get due to regulations and Bureaucracy.
- Need freshwater for the hatchery and household use. Check desalination option.

- No solution to get rid of the shells. Now burying in the sand on the beached. Crashing and powder options to produce lime and calcium should be evaluated.
- Need to improve transportation of employees to the relatively remote location on the beach.
- Need to mechanize some of the processes on the work platform to reduce heavy loads of manual work.
- Jose Luis Bellina, director of Acuapesca aquaculture firm, complains (http://fis.com/fis/worldnews/worldnews.asp?monthyear=1-2015&day=30&id=74278&l=e&country=&special=&ndb=1&df=1) that formal entrepreneurs compete on unequal terms with sea farmers who manage the so-called repopulation pens in Sechura. These producers are not subject to labour, environmental or tax audit by the Government, therefore, they have lower operating costs.

Picture 17: "Half shell with muscle and gonad" – one of the products at Aquapesca Processing plant.

Note: Palgey Maim Company can supply solutions to the following issues:

- Small footprint Desalination machine for the hatchery and services.
- Technical improvement on the scallops sorting and nets replacements on the work platform.
- Equipment and innovation.

Picture 18: Left – Work platform from the side. Right – Working crew sorting and restocking scallops nets

Considerations and recommendations:

The Government should consider to allocate more concessions for private and PPP (Public Private Projects) projects as JV (Joint Ventures) or other business models in order to make an impact on this industry and to regain higher production capacities which are on the decline in the last 2 years. The costs and benefits of small farmers seeding the sand bed versus commercial farming on lanterns in the column of the water should be further evaluated economically and socially.
Following we suggest that National program should be prepared by the Government considering all relevant key players in the industry (farmers, processing plants, traders, Gov. Officials and stake holders and more).
Bottom cultures made by fishermen are very risky because they surpass the carrying capacity of the areas they occupy. This brings also problems with the environment and bad image to the overall nearshore aquaculture.
It is necessary to facilitate the access to marine concessions, and to avoid speculation we see at present. The need to reduce procedures, time and costs now to become a marine farmer is a must. Promotion with education and precise, but friendly, follow-up of aquaculture ventures is also necessary instead actual attitude of repression penalties and fines (that all conduct to "informality"). Otherwise, strict sanitary control, is a need for all aquaculture types, species, methods, areas and products.

Aquapesca Scallops Processing Plant

The processing plant nearby on land employs about 400 people processing about 2000 MT of scallops per year.

Picture 18: Aquapesca Processing Plant, crew is packing frozen scallops.

Challenge and response: The risk of banning Peruvian scallop's exportation to Europe as indicated in the opening of the document and also mentioned above should be at the top of list for Government action plan to improve sanitation, bio security and supply management regulation as well as monitoring and controlling scallops in the farms and post-harvest. The Ministry of Production is currently working on SANIPES Action Plan to comply with EU sanitation regulation program. This program will include traceability and food safety measures for every producer and will improve QC and QA of Peruvian Scallops Industry and importation.

FONDEPES Institute in Tortuga Bay

<u>Picture 19:</u> Above - Google earth location of Fondepes. Below- Fondepes facilities on land and docks
FONDEPES: Government Marine research Institute

Mission – adapting new technologies and generating production protocol for marine aquaculture species. Working for the last 20 years.
Work currently under progress include working with:

- Local Peruvian Rock Sea Bass
- Local sea bream
- Local scallops
- ("Chita" *Anisotremus scapularis* = Peruvian Grunt)

Picture 20: Above left: Algae culture room. Above right: Lab. Below Right: concentrated algae culture tube. Below Left: fish R&D culture tanks research in progress: local marine species breeding and culture

Major immediate problem: Not connected to commercial power and are using too much diesel (about 40 Gallons per day at 11.50 Sol/Gallon).
This problem should be further investigated and Government efforts should be implemented.
Other proposals for the status are considered below.

Picture 21
Above left: R&D Scallop Farm location
Above right: Hand sort and count young scallops
Below Right: Lantern netting and preparing for young scallops stocking and installation in the sea

Observations and Considerations FONDEPES in Tortuga Bay:

The Institute is looking like a huge potential for R&D activities where only partially is being used and during my visit most of the indoor facilities were not active. The management and personnel on site are young professional aquaculture experts which are Igor to produce knowledge and technologies. The overall feeling we got was frustration of the potential ability to do a lot more for the local population and not enough resources to show and actually do it. From the short visit it is difficult to evaluate what are the internal and/or external problems, however, we suggest first to invest in the restoration of commercial power to the facilities and to work under the following considerations:

- Recall annual research and development program and budgets and adjust the program accordingly.
- Naturally, as in any other research facility, funds are limited and the R&D should not work under business like firm, but, as a Governmental arm to extract information from the field and supply knowledge and information for years ahead (minimum 5 years). This is very different than private business firms which must return their investment quickly. The proof for this approach is the results of the scallops industry who followed research and got this far because of research and not vice versa. Therefore research budget should be allocated based on Government' priorities and strategy.
- The scallops industry in the country now seems to be "Private Driven" which allow the private sector to lead the development of commercial scale existing farms while the R&D institutes should continue to support the industry by maintaining infrastructure to deal with potential problems such as environmental and other biological threats and risks. The ability of research stations to support and sometimes even save the industry is directly related to the human resources first and the budget to follow their work in the lab and in the field.
- The small and simple set up near the water where scallop larvae are produced and nursed and then, stocked in the water is showing that the technique and practical protocols have been mastered in this place and the people can transfer the technology to the local people in order to increase scallops production. This will enable small and medium scale farmers with limited budget to get into the scallops industry with little capital investments. The small scale farmers can join the larger scale (such as Aquapesca) and sell their scallops through their processing and marketing services.
- In order to generate income research institutes should consider to sign a contract agreements with farmers who are getting the training and knowhow from them, and when the farmers are profitable the research institutes should receive some royalties back. This will maintain income coming and keep research institutes ahead of the game.
- International research funds are another option to generate income. We can evaluate further a Joint Venture between Israel and Peru aquaculture and Mari culture research institute to generate international money available for such cooperation between countries. The Israeli Oceanographic Institute is interested to contact Government aquaculture authorities to check and suggest such options and alternatives. Palgey Main can connect between the two Governments authorities upon request.

Day 6: 11/3/17, LIMA, IMARPE

Visited research facilities and met with biologists and lab team staff. Now working on 3 main native species, both reproduction stimulations and culture potential based on fish growth performance:

1. *Paralabrax humeralis* (Peruvian Rock Sea Bass)
2. *Anisotremus scapularis* (Peruvian Grunt)
3. *Paralichthys adspersus* (Fine Flounder)

Keeping native phytoplankton and zooplankton in "microorganism's gene bank" under isolated well protected and bio secured facilities with temperature control and safe keeping.
Laboratories maintain living organisms with excellent care and super modern equipment including high tech microscopes and other equipment and tools.

Picture 22: MSc. Melissa Montes Montes is giving a tour at IMARPE R&D in LIMA

Met with IMARPE and FONDEPES Directors led by Mr. Jorge Zuzunaga, Director General del Acuicultura and Dr. Christian Berger discussed over the following issues with Government' considerations and ideas from all participants.

- To my question about an aquaculture forum or scientific panel to consult to the Minister about relevant aquaculture issues and developing interests, there is an aquaculture steering committee which meets on a regular basis ("round table") and it would be important to stay in touch with the committee during and after the study in order to bring together all internal efforts needed to promote the Government' aquaculture plan (increase production). Dr. Christian Berger will coordinate the work in this study and try to bridge between the ouput efforts with Government' plans and activities in order to maximize joint efforts results.

- The complexity of different departments and offices under the Ministry of Production including IMARPE, FONDEPES, ITP, SANIPES, INACAL as well as other legal structures and authorities such as ANA DICAPI and OEFA was explained and functions of the different offices were detailed. "Over regulations" should be avoided in parallel to maintaining and protecting the environment and natural habitats. This should be done in order to encourage "informal" farmers to become "formal". This issue should be of high priority in the "National Aquaculture Program"' list.
- Off shore marine culture was discussed with explanations about the social delicate issue to deal with local fishermen and maintain the 5 mile free zone. It seems that off shore Mariculture activities should not present any threats in this regards. Native and migratory fish are excellent choices for off shore fish farming along the coasts of Peru.
- The conflict between fish meal production and exportation from Peru and high fish feed costs in the country was raised and everybody agreed that further investigation should be devoted to this critical issue (fish feed is either hand made by the smaller farmers in the Amazon area, or imported from Ecuador for tilapia and shrimp). In addition, local production of fish feed in Peru (especially near aquaculture main locations such as Puno and Tarapoto) should be encouraged in parallel to the development efforts of aquaculture fish production, these two forces are acting together and should be monitored and even controlled by Government' support.
- Brazil on the East and Chile on the South are big fish producers. Ecuador in the North is the biggest America's shrimp producer. In this regard, efforts should be allocated to find out if Peru can learn and understand better the reasons and cause for this and act to improve aquaculture performance in Peru accordingly (this is beyond the scope of this study).
- The work in this study and our observations followed by concussions and recommendations will be available for this committee and considered according to Minister's expectations. Therefore, the work of this study will be presented to the Ministry and used to the best of its choice.

Day 7: 12/3/17, LIMA, Meeting with Frank Hartwich from UNIDO

Frank is working on the supply chain and aquaculture Business models project for the Ministry of Production and we are working on identifying potential technological and/or practical improvements in the different aquaculture sectors. Both issues are basically complementing each other enabling to increase aquaculture production. Therefore, we will join efforts to continue working together with UNIDO and with the Ministry in order to best implement the actual activities and projects in Peru which will be selected according to the Ministry' strategy and choices.

Day 8: 13/3/17, TUMBES

Picture 23: Above, Marinasol Marine fish breeding research program

Picture 24: Above: Marinasol Shrimp Genetic Improvement Program Cultivation and experiment tanks

Visit at Marinasol Shrimp Company facilities (Shrimp farm and Marine Fish R&D and Shrimp Hatchery)

The company is currently producing 8,000 MT shrimp per year. Intentions to increase production up to 50,000 MT per year subject to availability of land and water which are now limiting production.
The company is aiming to culture Marine fish species and now is working with Government and private funds on R&D projects spawning and breeding native marine species with special interest and focus on the following species:

1. Black Snook *(Centropomus nigrescens*)
2. Red Snapper *(Lutjanus peru*)
3. Peruvian Sea Bass *(Acanthistius pictus)*
4. Pacific Grouper *(Epinephelus quinquefasciatus)*

According to chief biologist Edissa Palacios about three years ago the company applied to the Government for a permit to grow fish off shore and the request has been denied. Providing such permit will be granted there is good chance that the company will consider investment in this direction especially with assistance from the Government which is not uncommon in such pioneering cases in other countries. This issue will be discussed further at the concluding chapters of this document.
There is great interest on the Black Snook, Róbalo Negro, *(Centropomus nigrescens)* which is a fast growing fish and can be cultured under aquaculture conditions. However, so far, spawning and reproduction of this fish in captivity in Peru has not yet completed and there is more research work to be done. This fish biology is similar to Barramundi (*Lates calcarifer)* and since Baramundi is being bred in Israel hatcheries commercially for the last two decades we will be able to offer assistance in the following ways (upon request):

a. Peruvian researchers and hatchery manager will come to work in Israel in hatcheries and research institutes specializing in Barramundi reproduction. There is a special request for this option from Marinasol.
b. Israeli Research institutes which mastered the reproduction protocols of Baramundi will join in with local private and/or public researchers in order to complete the life cycle of this fish and other Peruvian species with similarities to Mediterranean fish (sea bream and sea bass) which are bred in captivity and cultured commercially in the Mediterranean. This can be done with international and/or national research funds suitable for such cooperation between countries. We have approached the Israel Oceanographic & Limnological Research Institute http://www.ocean.org.il/MainPageEng.asp
   And they are most welcome cooperation in research work with Peru Government and private interesting groups. Palgey Maim will coordinate such activities upon interest and request.
   The company is looking to the Government to assist with this important need to close the gap and produce knowhow especially with regards to native and migratory fish with aquaculture potential both on land and in the sea.
   Visited the company Shrimp Hatchery and received full explanation about the impressive activities all around. The hatchery currently producing 1,350 million post larvae (*penaeus vannamei)* about 80% for self-use and 20% for external sales to local small shrimp along the north coast of Peru.
   The hatchery has its own genetic improvement broodstock program and PL qualities are getting better every cycle. The hatchery uses strict bio-security measures and recently the hatchery as well as the farms have been kept clean from disease and pathogens.
   Visit in IMARPE Tumbes

The staff and management showed us the research facilities near the coast. Working on Marine species. Some work is in parallel to Marinasol and IMARPE in Lima. Special research work done on the native lobster and oyster spawning inducing approaches. Also working on the local native Grouper as potential species for aquaculture.
Need better cooperation with field work done in private farms especially Marinasol which produces knowledge and is looking for knowledge from out sourcing.

Picture 25: Left, Visit IMARPE in Tumbes

Day 9: 14/3/17,

Juliaca: ARAPA TRUCHA FARM

Trucha Arapa was founded 27 years ago. Local farmers (mainly women) apply strict controls of balanced natural food. They don't use antibiotics or chemicals. Fish processed on site fresh directly from the cages. They have their own secret recipes for smoking trout with natural Andes wood which is considered gourmet in fine cuisine restaurants all over Peru.

Challenges:

1. Due to space and natural spring water limitation on land small fingerlings are stocked in the lakes too early and sometimes suffer from oxygen depletion especially when the temperature rise.

2. The farm is importing fertilized eggs from USA, therefore, not self-maintained and is completely dependent on supply availability. This issue is major Government' concern and will be discussed in the next section.
3. Some theft (about 3-4 tons fish every year).

Picture 26 Above: Hatching and Nursery manager (left) and aquaculture technician (right) at ARAPA TRUCH FARM (The farm is dominated by female management and staff)

Pictures 27, 28:

Left: ARAPA TRUCHA Farm Manager and processed trout fillets

Right: ARAPA Organic can Trout

Puno, Pisces Company, LAKE TITICACA

State of the art Trout cage farming technology including automatic water quality monitoring and control system, underwater cameras, fish pumps, sorting machine and more. The farmers monitor carefully fish performances and maintain strict bio security measures with excellent fish health condition.

Processing and packing plant in Puno and distribution nationally and internationally premium quality products.

Picture 29: Galvanized steel floating cage culture farm with state of the art aquaculture equipment

Challenges:

1. Importation of fertilized eggs expose the farms to the following threats and risks:
    a. Total dependency on outsourcing from USA. Political issues with United States should be taken into consideration especially under the new American Government.
    b. From the country's point of view fertilized eggs importation total around 10 Million USD every year which can be easily avoided when local trout hatchery will supply to the trout fish farms in Peru. Only with currency exchange saving there is enough saving to justify such hatchery in Peru.
    c. The culture of American Rainbow trout bred in America not in Peru may result in suboptimal performance of its young. Breeding should be done with brood stock cultured and breed under the local Lake Titicaca environmental condition and water.

Visited IMARPE in PUNO

R&D work is in progress with protection program of endangered species fish from Lake Titicaca. Benthic organisms are under threat and attempts to breed and spawn native species are in progress. Good contact and cooperation with fish farmers and provide lab services for diagnostic and prophylactic care if needed. The ability to maintain and offer these services in remote areas of the Andes should not be taken for granted and efforts to maintain and improve veterinary services and farm support from biologists and fish specialists should be evaluated and improved in budgets and personnel as a Government' priority.

Picture 30: Fish eggs Incubation tanks and aquariums at the Aquaculture lab in IMARPE Puno.

PALGEY MAIM

Summary of Challenges and recommendations for Improvements as part of a Recommended National Aquaculture Development Program to increase aquaculture in Peru.

General:

Following the Study/Survey in Peru described in details in the first part of the document above we will concentrate in the second part in specific potential practical solutions for immediate and short them challenges as well as longer terms Government' strategic approach of developing new sectors with strong base and infrastructures.

Summary of the Challenges identified in Study/Survey for major issues and Suggested Solutions:

1. Limited Water Resources in the Amazon region
    - Water catchment (dams), reservoirs, pumps and delivering canals (engineering).
    - Construction of ware resources projects according to priorities and budgets.
    - Water use regulation and control (Authorities structure and function).
    - Identify reservoirs and lagoons in the Amazon with aquaculture potential for cage farming (mostly for tilapia).
2. Tilapia Sector problems (Infrastructure, performance and sustainability)
    - Aquaculture consulting and support services by Government' professional agents.
    - Tilapia feed: evaluate alternatives to reduce feed prices.
    - Develop Tilapia products alternative markets.
    - Processing plant(s) near the fish farms.
    - Evaluate Business Models especially "Central – Satellite" Model and others (UNIDO).
    - Government' assistance with capital investments in new and existing tilapia farms.
    - Government' increase ability to regulate and promote hatcheries performance & quality.
    - Introduce aeration (air oxygen) with mechanical aeration based on costs and benefits.
    - Differentiate between Peru fresh (and frozen) quality tilapia products and the low quality tilapia importation from the Far East in order to establish **quality tilapia** marketing strategy and enable tilapia products to be sold as **premium product** in Peru.
    - Exportation of fresh tilapia to US should be evaluate further, however, due to logistics problems in Peru it will be difficult to compete with Central America and Brazil over the fresh tilapia market in the US.
    - Explore Tilapia cage farming in lakes and lagoons: cage culture operation require lower capital investment, offers increased management flexibility and have lower production costs as compared to ponds and raceways. Dr. C. Berger:" Cage culture of tilapia is already made in Piura – Poechos reservoir, and near Tarapoto: Lago Sauce. It is to note that in amazon lakes, new cage tilapia culture projects could find problems with environmental agencies, unless stocking certified sterile poliploids)"

3. Amazon fish are currently not exposed to Local markets in Peru (outside the Amazon) and this sector is generally underdeveloped.
    - **b.** Prepare comprehensive Business Plan to evaluate culture and markets potentials.
    - **c.** Encourage private investment as the "driving force" for this "niche" product and market which is considered "relative natural and native advantage" in the Amazon only.
    - **d.** Encourage to organize "Amazon fish" farmers into one group (organization) in order to gain more power and bring better results (than individually possible):
        a) Reduce feed costs by alternative source and local feed mills
        b) Obtain local processing plants
        c) Construct affordable aquaculture loans and financing options
        d) Present their needs and challenges in organized manner
    - **e.** Evaluate (by comprehensive business plan and Market research) an option to produce Amazon fish fingerlings (especially "Paiche") in the Amazon region and grow them to market size on the coast under RAS conditions near potential big markets (including supermarkets).
    - **f.** Locate potential lakes and lagoons in the Amazon which can be used for cage culture of Arapaima ("Paiche").
    - **g.** Introduce cage culture (based on f above) of Amazon fish in lakes and lagoons.
4. Scallops Industry is under constant threats from usual and unusual environmental conditions changes mostly El Nino. Note: this Study did not include a visit in Sechura bay, however, discussions with the Aquaculture directors elevated the problems in this region and its effects on the scallops industry. EU markets (especially France) demanding lately higher quality control and quality assurance for Peruvian scallops importation.
    - The small farmers should consider to raise the traditional culture scallops from the ocean sand bed and grow the scallops in lanterns (in the body of the water, elevated from the sand) as the mid-large size scallop farms do. This will require the following considerations:
        a) Social understanding if the local small farmers will be able to adapt?
        b) Introduce business models, Gov' assistance and promotion (incentives).
    - The Ministry of Production is currently improving **Food Safety** HACCP and quality control measures regulations for the supply chain for post-harvest protocols as well as **traceability** monitor and control systems. It is essential that these measures will penetrate down to the farmers' level and processing plants and will be presented to the EU authorities formally and publically according to international food safety standards of the Global scallops industry.
    - The exportation of scallops should be diversify and expanded to other international markets which can substitute individual countries threats which may ban frozen Peruvian scallops imports as they did 10 years ago with fresh scallops.
    - Large scallop's producers are driving this industry forward with private investments in modern technology and equipment. Government R&D of this sector should seek science limiting factors and biological risks which should be studied and able to service the scallop industry in unexpected risks in the future. The Government should

look into the gap between the industry and its research institute (if there is a gap) and close it accordingly.

5. R&D suffers from limited budgets due to different reasons which we will not try to evaluate here. However, Peru geographical structure and climatic differences in different regions create huge challenge to develop adequate research and developing which can be practically applied to every region, every sector in the region and every species in the sector.
    - Therefore, the Government should consider a separate National Program for the R&D institutes in order to locate and allocate budgets and professional personnel. In addition, Training courses in the Universities and even lower education levels, should be available and dedicated to all aquaculture disciplines (see below).
    - International research funds are available and Peru can access these fuds (which has been done so far as well) with international cooperation with Research Institutes in Israel and other countries offering to cooperate and provide good reasons for this.
6. Trout Industry (especially in Puno and Lake Titicaca) major identified problem is the dependability of this whole sector which are producing nearly 40,000 MT fish per year on the importation of fertilized eggs from the US.
    - The solution for this issue is relatively simple since the knowhow and technology is available to reproduce this species in captivity. There is no interest at this point to produce trout eggs in Peru because it is easier to order then upon demand with relatively little troubles and relatively low and economical price. However, the Government should look at it from National point of view and evaluate the benefits beyond the farmer's economic considerations.
    - Foreign currency saving considerations
    - High risks to be dependent on one country' ability to supply (even if it is USA)
    - No genetic improvement program of the genetic material most suitable for Peru conditions. Brooders from Lake Titicaca (and now they are "naturally" available to collect from the wild) are expected to provide better off springs performance in Peru and this may result in overall culture improvement to the farmers.
    - The Government should consider investing in such hatchery after business plan and market study is done and a design of such hatchery has be prepared. The most suitable location to build such hatchery should be part of the business plan suggested above.
7. The Shrimp Industry on the North West near Equator is progressing well with usual Peru' coastal aquaculture limitations and risks, especially during floods. The scale of production increase beyond the expected growth in the existing farms and their planning (for example, Marinasol is expected to grow from 8,000MT to 50,000MT) is not large due to climate and space limitation needed for further expansion. Due to this understanding the shrimp large producers (like Marinasol) is seeking to expand in different species of fish and are investing in R&D of Native aquaculture potential native species. A separate section below is dedicated to this topic.

The Challenge: Increasing Aquaculture Production in Peru:

Analyze of the Study Results and Evaluating the Feasibility Options and concept recommendations to the Ministry of Production:

Aquaculture has produced significant socio-economic impacts in the areas of the regions where it is developed, as in the case of the neighboring counties Chile and Ecuador. It is evident that the development of the aquaculture industry in the region is to great extent reflection of the degree of commitment shown by local governments.
The existence (or lack of) of an aquaculture development plan plays a very important roll and the coordination of work between the public and private sectors will promote the growth of the aquaculture industry and avoid duplication of efforts. This development must take place through the efficient and responsible use of natural resources (FAO Rome 2007 "Regional reviews and global overview").

In order to make relatively "big" impact on aquaculture annual production in Peru, which is the declared target of the Ministry of Production, there are basically two options (and/or their combination):

C. Improvement of **existing aquaculture sectors** (discussed above)
D. Introducing new additional sector: **Marine Fish Culture** (discussed below)

During the first part of the study we studies and evaluated aquaculture conditions in different regions which the study covered, and identified relative advantages and restricting local aquaculture limiting factors. During the study report we tried to analyze and suggest different options to solve specific and regional problems in order to increase productions in the different sectors with different relevant solutions. Overall R&D importance as key to advance and improve production in addition to private and public forces was also discussed.
Nevertheless, if we are looking for more considerable impact approach we need to understand that the existing active aquaculture sectors will reach their limits of production growth which will level at some natural point (and time) of equilibrium and balance between all the forces acting on them such as market, space, financing, environmental conditions and above all supply and demand.
About 95% of aquaculture in Peru is a combination of 3 sectors: **scallops**, **trout** and **shrimp**, and as mentioned above, have a natural expected growing curve process subject to overcoming the risks and challenges along the way, and investments from private and Government' together. The increase of the rest of the aquaculture products (5%), mainly Tilapia and Amazon fish, even at a remarkable rate, may not be able to achieve this desirable impact (at least not in the short and medium term periods). Having said that, Government should continue to promote and assist this part of aquaculture not only for the impact we are looking for, but, mainly for social and other National and Government' interests and considerations.
Therefore, we suggest, in parallel to the efforts for the existing sectors, to also look at other options for aquaculture growth potential in quantities at relatively shorter time. We are not altogether looking at something completely new, as some considerable efforts are being dedicated to developing in this approach; for example, Marine fish reproduction and culture techniques which

are currently in progress both at the private and Government' institutes at high interest and study levels.

After analyzing what we have seen and learned during the study, we suggest to concentrate on the following issues and according to the following principles:

1. **Concentrate efforts and study on the Peruvian sea. It is considered "unlimited" in its potential!**
2. **Focus on breeding efforts mainly of native and migratory fish from Peru Sea with fast growth capacity (at least fish which can grow from 1 gram to 1 kg in 1 year (1:1:1) or better.**
3. **Focus on 2 new main advanced technologies of <u>marine fish culture</u>:**
    a. **RAS of marine fish on shore (relatively close to Markets)**
    b. **Off Shore fish farming technology (relatively near ports or docks)**

<u>The Marine Fish culture Sector:</u>

New Technologies
New Fish
New approach
New sector of fish farming in Peru

INTRODUCTION (a pick at the neighbor from the South):

Although Marine culture in the neighboring country Chile is mostly of cold water fish, especially salmon, some considerations are similar in Peru when looking how to further develop the aquaculture industry.

In addition to the introduction of valuable genetic material, Chile has benefited from a variety of both capital and technology transfer from other salmon producing countries such as Norway, Scotland and Canada that has facilitated the rapid growth of the industry. Relevant fields of technology have included nutrition, fish health management and husbandry techniques, as well as cage culture system (FAO Rome 2007 "Regional reviews and global overview").

Aquaculture Success in Chile has been greatly facilitated by the country's commitment to free trade and open markets. This has been complemented with a series of trade agreements with United States, the European Union and Republic of Korea among others

During recent years in Chile and other parts of the world, the combination of young fingerlings and fish culture on land under RAS conditions and then, completing their culture in cages in the sea, is proving to be the best formula to culture marine fish successfully. This method allows for the well development of strong fingerlings on land, and then, provide them with the best natural environment to grow to market size – the off shore sea conditions.

Our proposal to focus on **off shore** aquaculture and not **near shore** cage faring in Peru is based on understanding mostly the need to protect the nearshore ecosystem and environment, as well as also to get away from the risks of occasional floods with heavy nutrients and mud deposits near the shore of Peru. This strategy of fish farming off shore will reduce, or even eliminate, the conflict of interests with artisanal fishermen since most of their fishing activities are at the "5 miles fishing zone".

Note: During meeting with Vice Minister Hector E. Soldi Soldi and according to the Vice minister suggestion, we recommend that the proposed **National Aquaculture Developing Program Committee** will investigate and prepare a special **"off shore fish farming program"** which will include the National and International **Oil drilling Companies** as potential investors and stake holders in this sector. The Oil companies can gain twice by participating in the aquaculture developing program in Peru: First by "writing off" their investment in aquaculture for tax return purpose, and also to improve their image of supporting the environmental and social concerns.

Recommended Option 1: RAS (Recirculated Aquaculture System) on land - Technical Description

Technology Description:

Today there are up to zero-discharge (100% recycled) RAS technologies. The RAS can accommodate anaerobic filtration with the combination of aerobic filtration in order to have a complete 100% recirculating fish farms.

The systems are mostly indoor fish farms, based on controlled climate environment in order to maintain the needs of the grown specie - the product. The farm design is adaptable to the climate, specie biological demands and budget.

The system we suggest to consider in Peru should include four phases fish farm (Quarantine, Nursery, Grow-Out, and Purging units). The design of the farm includes all the facilities needed for the operation of the farm and is supported by the supplier consulting package until training is completed and the management is handed over. The System should provide a full solution, from fingerling stage to full size packed fish to the market, or as indicated above, will grow fingerlings to acceptable size when they will be transferred to marine off shore cages.

The RAS Advantages:

A. Can grow any specie, salt-water, brackish or fresh water fish in any location.
B. Location can be anywhere, even close to cities markets
C. Zero-discharge, up to 100% recycled – Zero impact to the environment!!
D. Full solution from fingerling to the market.

The suggested RAS should include the following elements:

A. Aerobic filtration.
B. Anaerobic filter.
C. FF- Protein Skimmer (If needed).
D. Mechanical filtration (If needed).
E. Sterilization systems (U.V Units or/and Ozone systems)
F. Control Systems (flow, oxygen, temperature etc.)
G. Day & night controlled lighting.
H. Climate controlled buildings.
I. Pumping units.
J. Oxygen controlled units.
K. Complete utilities systems.
L. Alarm systems.
M. Harvest systems (If needed).

Technical Data Requirement:

The RAS should supply complete biological cycle, fully self-controlled by the system components, elements and the team management. Each system is designed to give full solution for the chosen specie/s. The system elements and team will give solution for the specie needs as follow:

A. Biological Plan, which includes growth densities at each stage, feeding charts, growth rates, survival assumptions, flow rates for each stage, harvesting plan, optimal conditions etc.
B. Sludge biological disposal.
C. Nitrogen disposal (NH3, NO2-, NO3-).
D. CO2 disposal.
E. Optimal oxygen growing range.
F. Optimal temperatures growing range.
G. Optimal water chemistry for all growing stage.
H. Operating and biological protocols (prepared specially in each location with the local team).
I. Daily multiple lab tests (water & fish tests).
J. Disease control & treatments protocols including preventing measures.
K. Harvesting and chilling methods that will keep freshness for long shelf life.
L. Maintenance plan & protocols for keeping system efficiency and life span.

Potential Species List (for inland). More native species should be further evaluated (especially "Paiche"):

RAS are mostly flexible to adjust to any cultivable species and we believe that can provide the best conditions to grow almost any specie that is available in terms of fingerlings source.

The System can be adapted to various types of buildings, tanks, climate etc. to enable the grower to provide the right solutions for any specie, as the main concern is the ability to recycle and control 100% of the fish environment.

Some of the species known to be commercially cultured under RAS technology:

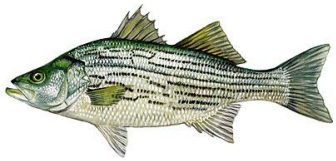
Specie	Picture	Growth rate (12 months)	FCR	Survival rate	Salinity	Location
Sparus aurata – Gilt head Seabream		400-450 grams	1:1.6	85%	10-30 ppt	Israel, New York
Dicentrarchus labrax – European Sea Sass		380-450 grams	1:1.6	85%	5 – 30 ppt	New York
Morone saxatilis – Striped Bass		700-800 grams	1:1.7	90%	5 – 30 ppt	New York
Seriola Lalandi – Yellowtail Amberjack		1800-2200 grams	1:1.4	88%	20-30 ppt	New York
Atractoscion nobilis – White Sea Bass		700-800 grams	1:1.7	80%	25-30 ppt	New York

Oreochromis niloticus -*Tilapia*		700-800 gram	1:1.7	85%	Fresh water	Israel

Availability of more species with good potential for RAS inland (subject to fingerlings availability):

A. *Lates calcarifer* – Barramundi.

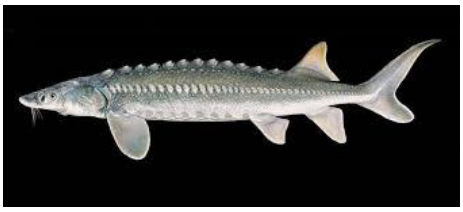
B. M. chrysops x M. saxatilis – Hybrid striped bass



C. Catfish SP. (African catfish, Pangasius etc.)

D. Trout Sp.

E. Sturgeon Sp.



RAS is also an excellent technology for Peru Native species such as: Fine Flounder, Peruvian Grunt, Peruvian Rock Sea bass (*Paralabrax humeralis*) and more.

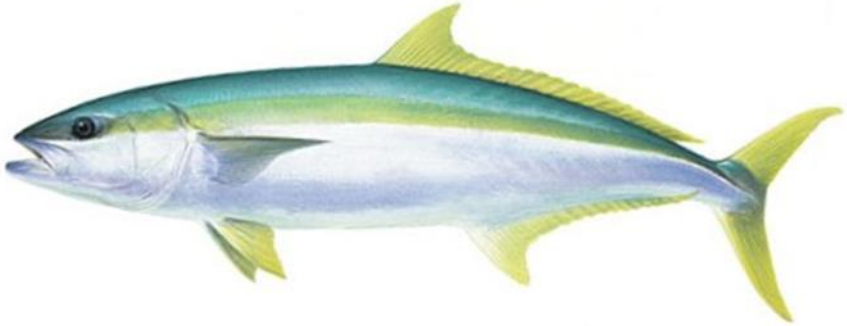
Note: Upon request we shall prepare specific proposal to the (based on location, species and annual production) to the Ministry of Production for the Engineering of such RAS and ability to supply the technology, protocols and training.

Indoor RAS is suitable for any fish species selected for culture under controlled and protected environment.

Species selection for Marine culture in the sea

The leading fish from the list described in section for the preliminary pilot stage of this project is Yellow Tail from the first year and/or any other Peruvian native or migration fish according to Government' choice.

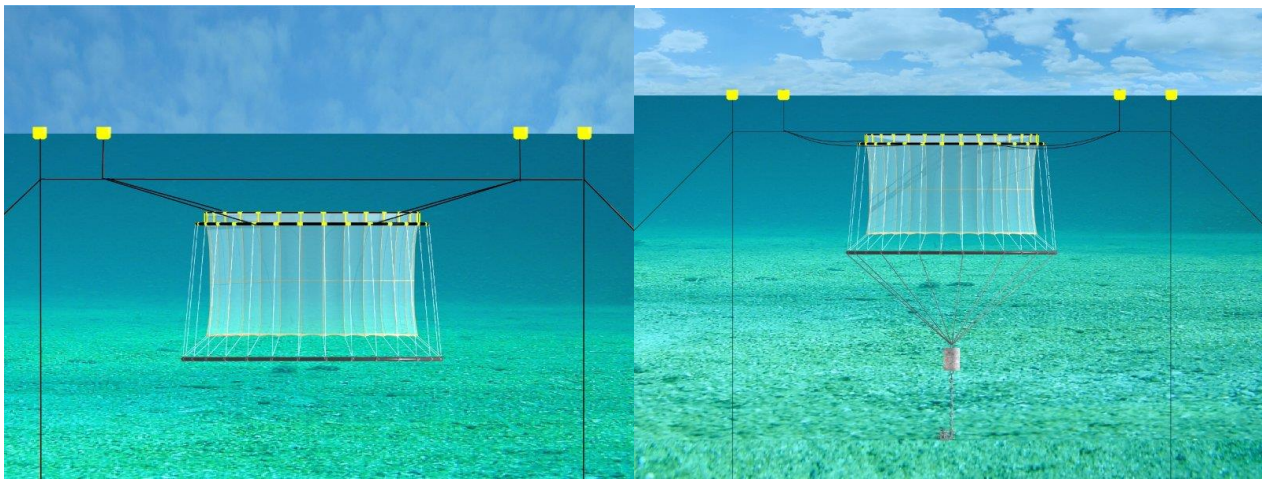
Yellow Tail (King Fish)

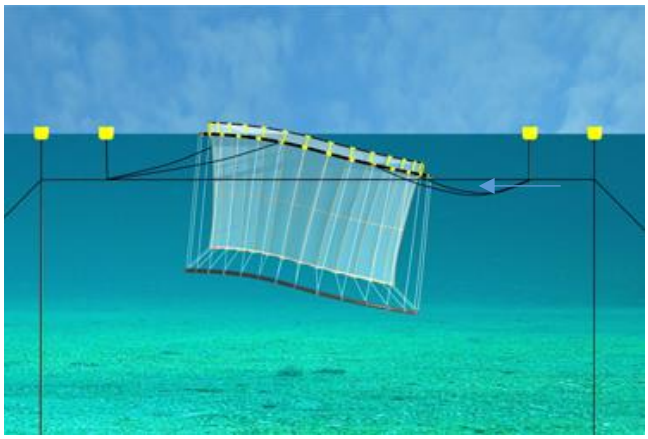


Recommended Option 2: Cage Culture Aquaculture technology

A few submersible technologies should be considered, studied and selected for the Government' appointed site(s) in Peru off shore waters. **We suggest to the Government' Ministry of Production to choose the appropriate technology based on costs and benefits considerations as well as site(s) specifications**. Below pictures and explanations of a few different types of cages systems:

1. Badinotti submersible cages

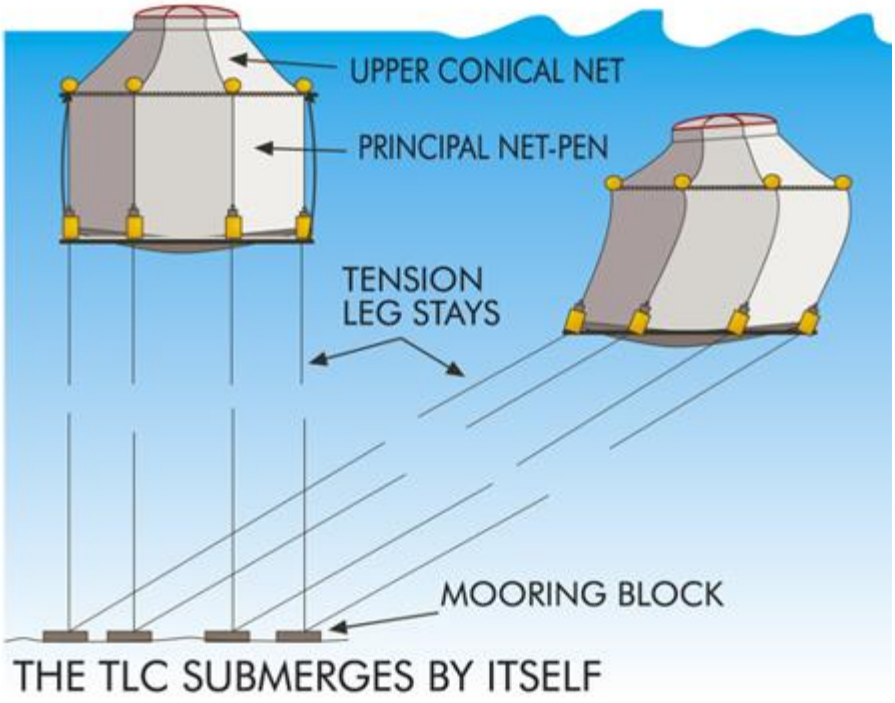


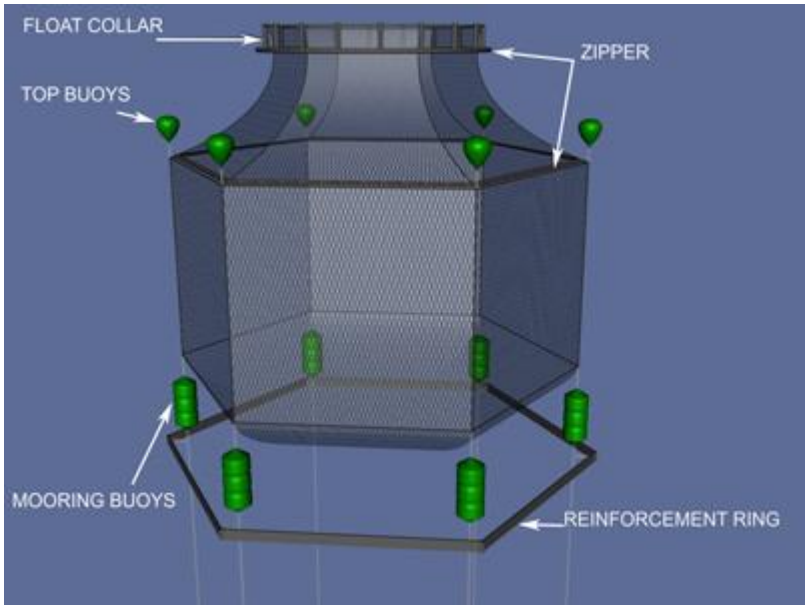


An example of submersible cages by Badinotti
http://www.badinotti.com/pord_sub_cage.html
There are a few different other qualified suppliers which will be considered for the project. The example is for concept explanation only.

E. **Subflex:** https://www.youtube.com/watch?v=FneHF86v5f0

F. **TLC (Tension Legs Cages) by REFAMED**
http://www.refamed.com/TLC_SYSTEM/DESIGN/design.html


UPPER CONICAL NET
PRINCIPAL NET-PEN
TENSION
LEG STAYS
MOORING BLOCK
THE TLC SUBMERGES BY ITSELF


FLOAT COLLAR
ZIPPER
TOP BUOYS
MOORING BUOYS
REINFORCEMENT RING

Closing Chapter:

The Ministry of Production of the Peruvian Government has now the information we collected, analyzed and submitted in this report and Study/Survey done by our specialists Ramy Alon, Eng. Amos dank and Eng. Ran Weinstein from Palgey Maim Company.
The first part of the study described in details our findings and recommendations as we identified limiting factors to the best of our ability to cover all aquaculture sectors according to the survey program.
In the second part we concentrated on the option to increase aquaculture production with new technologies and marine fish species.
The Ministry of Production should take this study/survey as professional advice and not as a scientific paper and should proceed and evaluate its actions according to Government' considerations and interest.

We recommend the Ministry of Production to organize **National Aquaculture Development Program** which will include aquaculture developing plan and budgets which will include:

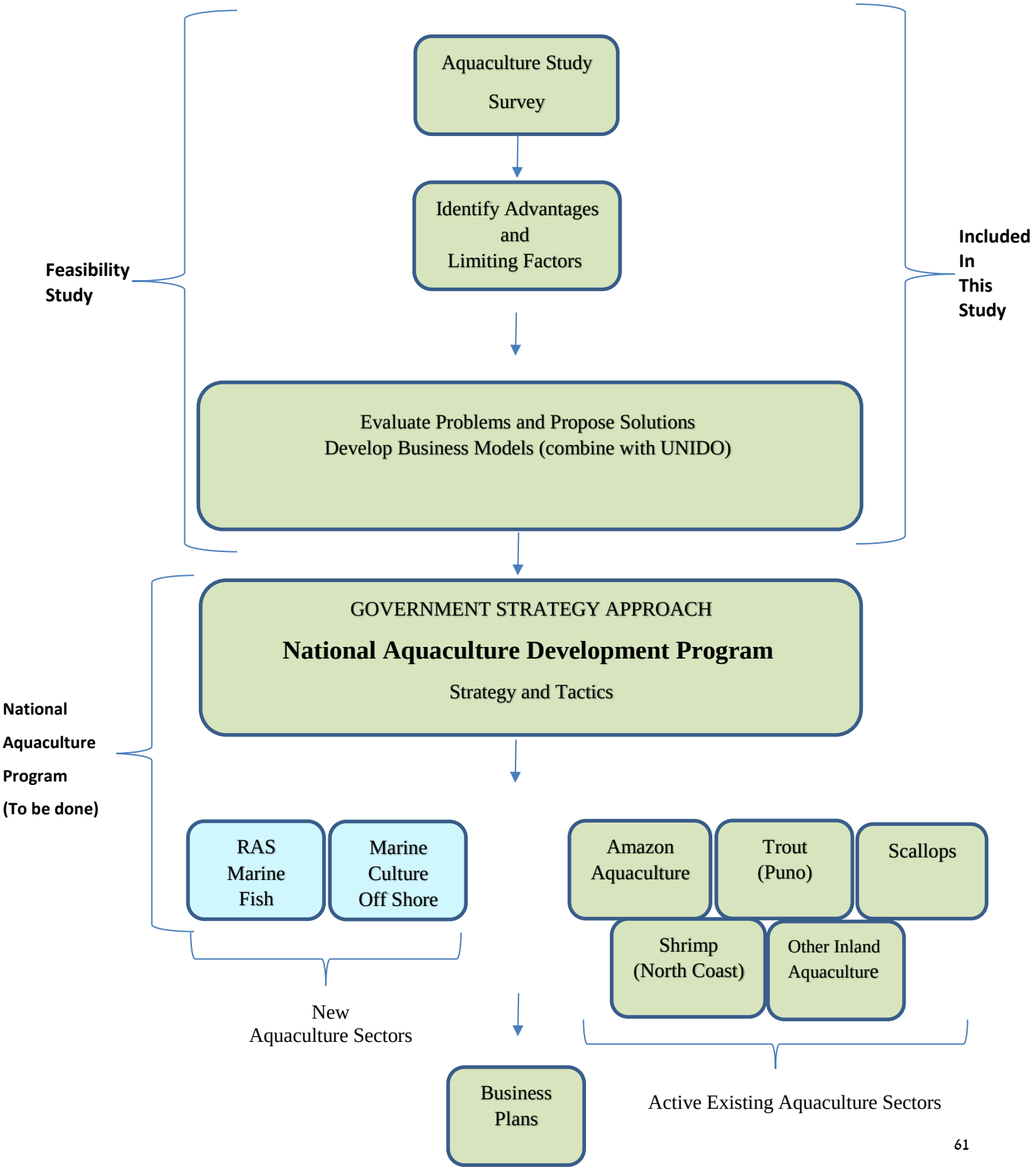
A. **Strategic Plan** (which sectors and regions to develop and invest as Government including existing and new sectors) considering the study and other Government' considerations.
B. **Tactics Plan** (how to allocate the budget, and what are the action items of the plan)

The following basic aspects should be taken, first, into consideration by the Government when approaching the challenge to Increase National Aquaculture Production in Peru:

1. Financing
2. Social
3. Regulations
4. R&D and Veterinarian service
5. Education and Training
6. Advanced Technology
7. Infrastructure
8. Accessibility
9. Electricity
10. Water resources
11. Logistics
12. Markets
13. Sustainability (including Business Models)
14. New culture species and sectors

The proposed mechanism to generate the **National Aquaculture Development Program** is described below:

The sketch below presents the reasonable process needed and recommended for the Government to proceed:



Proposed ACTION ITEMS for the Peru Government to proceed:

1. **Form a National Aquaculture Committee which will be responsible for the following:**
    a. **Prepare a "National Aquaculture Program" with advice to the Minister on the Strategy:**
        i. **Selected and recommended Aquaculture Sectors to promote and invest**
        ii. **Recommended Regions to develop**
        iii. **Recommended Species to develop**
        iv. **How to invest the funds for the best "cost vs. benefits" results and based on business plans**
2. **Define the allocated Government' Budget for the National Aquaculture Program**
3. **Define the mechanism, rules and regulations how to invest the Government' funds in the National Aquaculture Program.**
4. **Prepare details of the program: what? Where? How? Based of business plans and engineering.**
5. **Execute the National Aquaculture Development Program**

Palgey Main Company Tentative Proposal (Upon Request):

We, Palgey Maim Aquaculture and Water engineering company will be glad to offer and provide our services according to Government' plan and program. Following some of our services we wish to offer as a result of the study/survey which are directly related to our recommendations, including:

1. Participate in the proposed (see above) **National Aquaculture Committee** of the Ministry of Production in order to assist the Committee to prepare **National Aquaculture Developing Program** and provide aquaculture consulting services as needed. This program should have a budget and action plan (for example, to participate (invest) in a model pilot project of RAS and/or Off Shore marine fish farms in Peru).
2. Engineering planning of water catchment and water holding (dams and reservoirs), and design water channeling systems to fish farms in the Amazon region (especially in the highlands of San Martin) where topography is excellent for this water resources and use options.
3. Design and engineer cage culture systems and farms for Tilapia and Amazon fish in lakes and lagoons in the Amazon.
4. Prepare a comprehensive Marketing research and Business Plan for Amazon fish in Peru and export markets (especially "Paiche"). In addition, for other fish and other regions if needed.
5. Introduce tilapia hatchery system (kit) including protocols, training and genetically improved brooddtock supply from Israel.
6. Design and engineer **Central Farm – Satellite Farms** Model based on location and business considerations.
7. Design and engineering for the conversion of the Tilapia Farm at Acuahuara to super intensive shrimp farm.

8. Design and engineer water treatment plants for the effluent of water from fish farms to the sea near the coast (especially organic matter, ammonia and excess minerals) to comply with strict Government regulations and allow the use of more sea water for coastal aquaculture on land
9. Supplement desalination technology to marine fish farms and scallops land base facilities near the sea.
10. Aquaculture Field equipment and technical support to scallops farms (mechanize some labor intensive work on the working rafts during handling of nets replacements and sorting scallops).
11. Bring together Peru – Israel Governments R&D institutes to join in research programs funds and share knowledge between the Institutes to speed up Peru' scientific process (public and private) of breeding native marine species.
    a. Specific example: the chief biologist of MARINASOL has expressed the Company's interest to send her for training in Israel and practice in Baramundi breeding technique which is similar to the breeding of the Peruvian Black Snook.
12. Design and engineer trout nursing facility under RAS conditions to increase fingerling size before stocking in cages (ARAPA and other trout fish farms in Lake Titicaca).
13. Marine RAS technology: Design and Engineering, technology supply.
14. Off Shore farming technology: Design and Engineering, technology supply.
15. Any other Aquaculture Engineering and water engineering needed based on the National Aquaculture Program.

Thank You:

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Sincerely,

Ramy Alon Amos Dank Ran Weisman

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Palgey Maim Company
Israel