

**Plurinational State of Bolivia
Preparatory Survey on BOP Business on
Re-circulating Aquaculture System for a
Sustainable Water Supply in Rural Areas
(BOP Business Promotion)**

**Final Report
Summary**

November 2013

Japan International Cooperation Agency (JICA)

Earth System Science Co., Ltd. (ESS)

O S
J R
13-101

**Plurinational State of Bolivia
Preparatory Survey on BOP Business on
Re-circulating Aquaculture System for a
Sustainable Water Supply in Rural Areas
(BOP Business Promotion)**

**Final Report
Summary**

November 2013

Japan International Cooperation Agency (JICA)

Earth System Science Co., Ltd. (ESS)

Foreign Currency Exchange Rates (as of July 2013)

Currency	Exchange Rate (1USD)
Japanese Yen	98.07
Boliviano (Bs.)	6.76

(source : JICA)

Table of Contents

	Page
1. Current Situation Survey at the Project Area	1
(1) Investment/Business environment.....	1
1) Political/Economic situation.....	1
2) Policies and legal systems for general foreign investment.....	1
3) Policies and legal systems for the project	1
4) Current market situation of fish products	2
5) Target purchasers	3
6) Existing infrastructure	4
7) Weather conditions	4
(2) Survey of the project plan.....	4
1) Project site	4
2) Demand for fish products.....	6
(3) Survey on development effectiveness (state of target BOP group).....	6
2. Building a business model and developing a business plan	7
2.1 Building a BOP business model.....	7
(1) Business model	7
(2) Business strategy	8
2.2 Business plan.....	10
(1) Product development.....	10
(2) Procurement of equipment and materials	14
(3) Facilities plan of the core operating company	14

(4) Shipping and sales plan of the core operating company	15
(5) Staffing and human resource development.....	15
(6) Business partner and cooperative NGO.....	16
(7) Project costs of the core operating company	16
(8) Financial analysis.....	16
(9) Fund raising plan.....	21
(1 0) Risk management.....	21
(1 1) Approval and license.....	21
(1 2) Project implementation schedule.....	22
(1 3) Environmental and social considerations	22
3. JICA's projects to be implemented coordinating with the BOP business....	22
(1) Japanese ODA scheme and projects that can be cooperation with the BOP business.....	22
(2) Prediction of the effect of cooperation.....	24
4. Prediction of development effectiveness and formulating scenario for expression of development effectiveness.....	24
(1) Indicators of development challenges to be solved through the BOP business	24
(2) Analysis on the baseline data related to the development indicators.....	24
(3) Scenario for expression of development effectiveness after the start of the BOP business	24
(4) Target of indicators related to development challenges	24
5. Experimental Cultivation	25
(1) Monitoring of the existing nurseries	25
(2) Experiment on carrying density.....	25
(3) Experimental cultivation using re-circulating aquaculture system.....	25
(4) Taste test	25

(5) Food hygiene inspection for frozen fish	26
(6) Tolerance test against a drop in water temperature.....	26
(7) Floating efficiency test of feed.....	26

1. Current Situation Survey at the Project Area

(1) Investment/Business environment

1) Political/Economic situation

The central government of Bolivia is a constitutional republic, it has changed the name from “Republic of Bolivia” to “Plurinational State of Bolivia” (hereinafter “Bolivia”) in March 2009. Although the prefectural government of Santa Cruz is the position of the anti-government against President Evo Morales administration, anti-central government school are few municipalities within the prefecture. However, cooperation agreement has been signed between the municipal governments and the prefectural government, and the relationship is relatively good

Although economic conditions have been growing relatively smoothly over the past several years, poverty alleviation which is the largest domestic issues is still far from the solution and there is a harsh reality of the country. The central government is committed to development of fields such as “education”, “health sector” and “water and sanitation” as social development for poverty reduction. In terms of "water" in particular, underdeveloped situation in rural areas is remarkable for drinking water supply in the country.

2) Policies and legal systems for general foreign investment

Registration work and management for companies is entrusted to FUNDEMPRESA. According to interviews with management director of FUNDEMPRESA, establishment of joint ventures and foreign investment are unregulated in particular other than company registration as well as domestic companies.

3) Policies and legal systems for the project

For productive activities, both the prefecture and the municipalities support villages in various fields. Santa Cruz Prefecture has been carried out productive activities support referred to as the "Fondo Rotatorio" for the purpose of food security since the 1970s. For example, the prefecture encourages farmers to breed pigs and chickens providing piglets, chicks and technical guidance. When the farmers bred them and get next piglets and chicks which are born by the bred pigs and chickens, the farmers can freely dispose of 50% of piglets and chicks as their own products, and the remaining 50% are provided to the prefecture as a reward. As the next step, the prefecture provide the piglets and the chicks to other farmers, and such productive cycle is sustained and expanded.

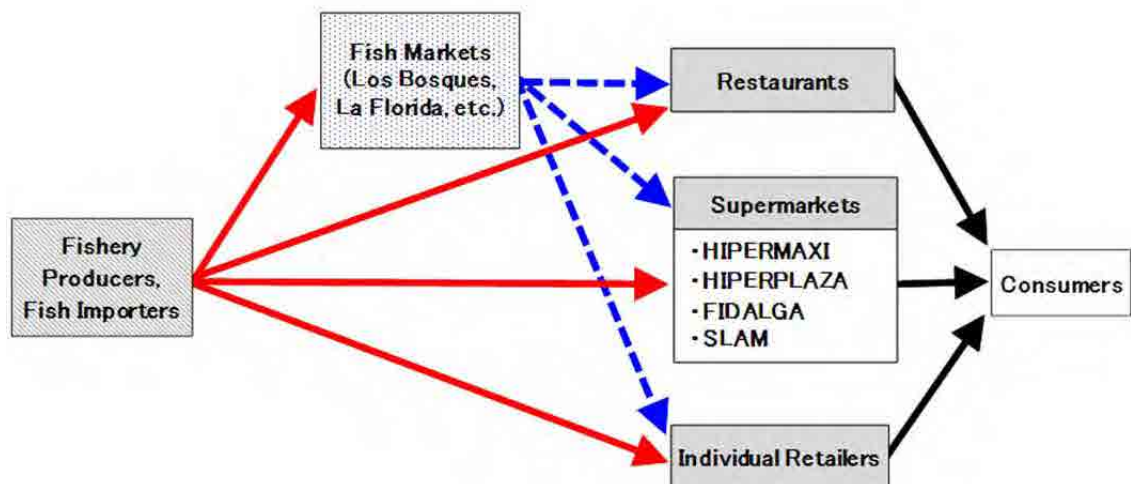
In recent years, as part of the productive activities support, the prefecture and municipalities have begun to assist villages in starting aquaculture. They assist villages in constructing fish rearing ponds or providing fry/feeds and technical guidance.

4) Current market situation of fish products

a) Current state of the fisheries market

According to the data of CEPAC (Centro de Promoción Agropecuaria Campesina), distribution amount of fish in Santa Cruz Prefecture in 2008 (3,553 t/yr.) accounts for about 45% of total amount (8,003 t/yr.) of major four prefectures (Santa Cruz, La Paz, Cochabamba and Beni) . It means that Santa Cruz Prefecture is the most fish-distributed prefecture in Bolivia. On the other hand, the distribution amount of Santa Cruz Prefecture does not rely mainly on supplies within the prefecture but on imports from Argentina. It can be said that a fishery has not been established as a local industry of local production for local consumption.

In Santa Cruz City, aquatic products are distributed along the paths shown in Figure-1.1. Most aquatic products (84%) are flow into the fish markets and sold there. In the fish markets, fresh fish are sold wholesale and some restaurants cook and serve them there. In Santa Cruz City, people seem to like to eat fish out rather than cook and eat it at home.



Figure— 1.1 Distribution channels of aquatic products in Santa Cruz City

Improvement in income due to the economic development in recent years tends to increase demands for eating out, variety of foods, diet or health-oriented foods, which also has increased the demand for fish. On the other hand, fish resources in rivers have sharply decreased due to water pollution or construction of dams, which has increased the fish price. As the value of fish has increased, fish food specialty restaurants are increasing in Santa Cruz City. Those background convince us that the fish-eating culture would not fade away and that there would be enough room to increase fish consumption if the problems of freshness or cooking are eased..

Most of the aquatic products come into Santa Cruz Prefecture are gathered at fish markets in Santa Cruz City for a short time, and distributed to Santa Cruz City and other areas within the prefecture.

During January to February in year 2013, with assistance of officials of Santa Cruz City, the survey was carried out interviewing persons involved in fish markets, fish importers, restaurant managers and hotel managers in Santa Cruz City in order to obtain the latest distribution of aquatic products in the prefecture.

As a result, the annual distribution amount of fresh fish in Santa Cruz Prefecture was estimated to be 6,867t/yr., which is about twice as much as 3,553t/yr. in the year 2008 quoted from CEPAC data. In addition, the distribution amount of Santa Cruz City was estimated to be 5,260 t/yr. that accounts for 77% of the distribution amount of the whole prefecture.

As the government's price adjustment has not been made with respect to fish, the price fluctuation of fish is larger than that of meat. The price has almost doubled in the past five years. According to the results of the survey carried out in July-August 2012 interviewing managers of supermarkets and fish markets in Santa Cruz City, unit selling prices of fresh Paku (without guts) are sold at Bs.40 - 50/kg and those of Pacu processed into fillet are at Bs.50 - 60/kg.

b) Current state of the existing aquaculture industry

Existing fish farmers in Santa Cruz City and its suburbs are classified into two large groups. One is a group of individual management and the other is a group of community-based management that organizes an fish farmers' aquaculture association and is supported by the prefecture or municipalities. A large-scale fish farm with a form of business enterprise has not established yet at present.

Advanced fish farmers under individual management try to obtain knowledge and skills of aquaculture learning from Gabriel René Moreno University or neighboring countries like Brazil or Peru. Fish farmers under community-based management are provided guidance from advisors dispatched from the prefecture or municipalities. However most of those advisors are originally experts on agriculture or animal husbandry and there are few advisors who have sufficient knowledge and skills. According to the data of Santa Cruz City Farming Union (CAOR), annual total harvest of Pacu in Santa Cruz City is 127t/yr. in year 2012.

5) Target purchasers

According to the data of INE (National Bureau of Statistics), reflecting the trend of the total population growth at national level, the population of Santa Cruz Prefecture (2,863 thousand people, in 2011) tends to increase and its growth rate may exceed that of the total population of Bolivia (10,624 thousand people, in 2011). Especially, the total population of Andres Ibañez County (1,893 thousand people, in 2011) including Santa Cruz City accounts for 65% of the total population of the prefecture and it is said that the rate has increased further in recent years.

Santa Cruz City (Santa Cruz de la Sierra), a core urban community of Andres Ibañez County, has the total population of 1,698 thousand people in year 2011, which accounts for 59% of the total population of the prefecture and 90% of the total population of the county.

In addition, according to the data of FAOSTAT, the fish distribution amount at national level has increased steadily about 1.4 times in the past eight years from 2001 to 2009. Its increase rate exceeds 1.2 times of the total national population growth. Fish distribution amount within Santa Cruz Prefecture is 3,553 t/yr. (CEPAC, in 2008) and estimated to be 6,867 t/yr. (the survey in January – February, 2013). Although there are only two data with different sources, the fish distribution amount has likely increased 1.9 times in the past four years from 2008 to 2012

6) Existing infrastructure

With regard to road condition in Andres Ibañez County, only 19% of roads are paved and the remaining 81% are unpaved (source: homepage of the Road Service Department of Santa Cruz Prefecture). Fortunately candidate villages for aquaculture units are located along the trunk road, Route 4, which extends east from the center of Santa Cruz City to the direction of those villages. Using Route 4, access to the aquaculture units is in good condition. It takes one hour at most to drive from the center part of Santa Cruz City to the aquaculture units.

7) Weather conditions

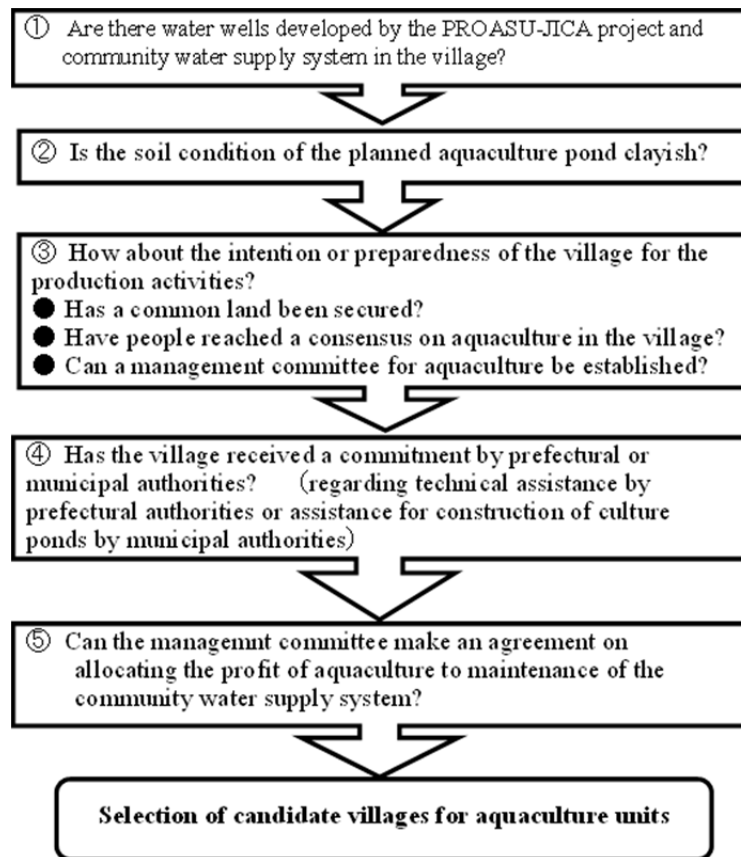
As Santa Cruz City (17 ° 47'S latitude, 63 ° 10'W longitude, altitude 416m) and its suburbs belong to the tropics of the Amazon basin, temperature is generally high throughout the year. However, in the winter time (from May to August), there is a sudden fall in temperature once the south wind called “Surazo” blows, and daily maximum temperature sometimes falls below 20 °C.

According to the temperature data observed for more than 20 years by Santa Cruz meteorological station of SENAMHI (Bolivia Meteorological and Hydrological Services), daily minimum temperature sometimes goes down below 5°C during the winter time from June to August, most likely in July. Recently daily minimum temperature of 4°C was recorded in July 2010. It is said that mortality of aquatic life occurred in the natural water areas at that time, and fish farmers in Santa Cruz Prefecture suffered huge losses due to the mass mortality of cultivated fish.

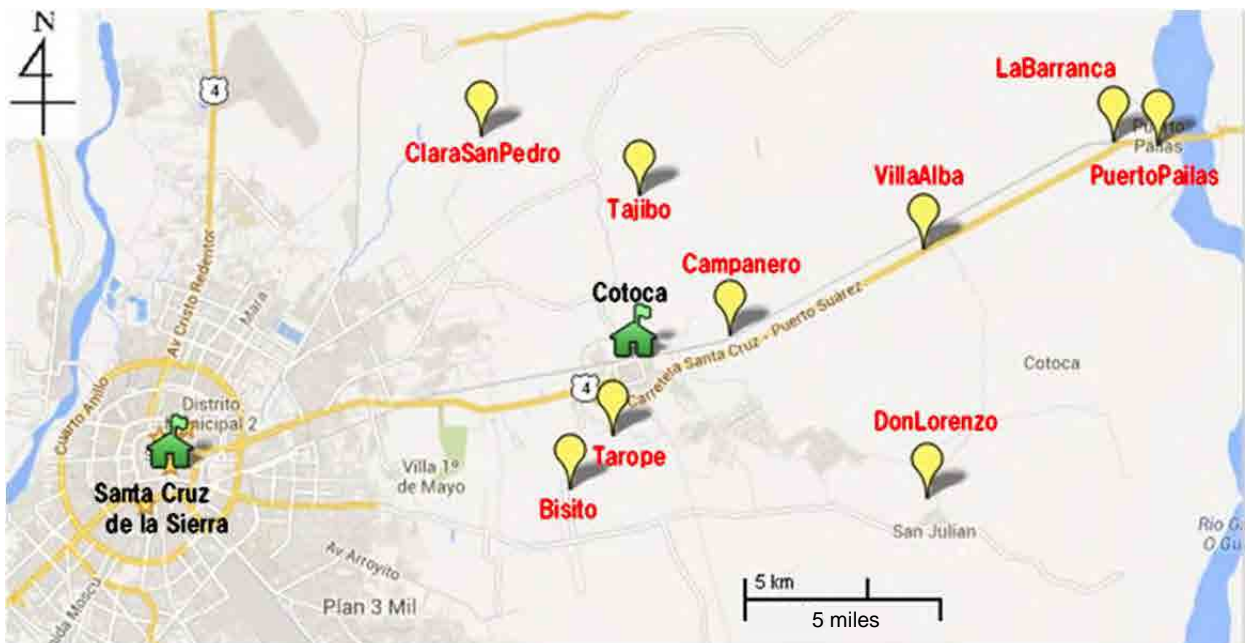
(2) Survey of the project plan

1) Project site

To select candidate aquaculture units, Andres Ibañez County was selected as a target county first of all. Because Andres Ibañez County holds Santa Cruz City, a large consumption area, in its arms and is easily accessed from the center part of Santa Cruz City. Among cities of the county, Cotoca City was next selected as target city. Because in Cotoca City, there are villages where aquaculture has started with the assistance of the prefecture and municipalities and also many villages which meet the conditions of the BOP business. Finally, with the help of Cotoca City, nine village have been selected as candidates for aquaculture units considering the selection procedure as shown in Figure-1.2. The location map of nine candidate villages is shown in Figure-1.3.



Figure—1.2 Selection procedure of candidate villages for aquaculture units



Figure—1.3 Location map of candidate villages for aquaculture units

2) Demand for fish products

The questionnaire survey was carried out on residents of two villages, a part of candidate villages for aquaculture units. In both villages, to the question about the interest in fish farming, more than half residents answered "I am interested in aquaculture business".

To the question about the form of operating business, 75% of the respondents answered "joint management in the rural community", and more than 90% of them answered "I am willing to take part in not only fish farming but also selling products". Residents

As general intention of the communities, they have much interest in aquaculture business and the communities want to manage the business by themselves as much as possible.

(3) Survey on development effectiveness (state of target BOP group)

The survey was carried out interviewing to the water supply management committee in each target village. The results are shown in Table-1.1. It is a reality that the water management committee operates and maintains the rural water supply system at the very least within the limited budget by the revenue from water charges and squeezes a slight reserve for renewal/expansion of water supply pipe network and updating of well pump.

For the last 11 years from 1998 to 2009, Tarope Village expended about Bs.20,000 for ordinary operation/maintenance costs (utility costs, pipe network maintenance costs, material costs, labor costs, etc.) and Bs.169,644 for extra maintenance costs (costs for well pump replacement, expansion of pipe network, etc.). Thus Tarope Village needs to set aside at least Bs.16,000 every year for the reserve in order to ensure the budget for renewal/expansion of facilities and the sustainability of the community-based water supply system.

Table— 1.1 Maintenance costs for water supply system in the candidate villages (Year 2011)

No.	Name of village	Population	Number of households	Maintenance Cost (Bs./yr.)	Revenue from water charges (Bs./yr.)
1	Clara San Pedro	180	39	15,240	15,840
2	Campañero	2,240	320	30,000	46,080
3	Puerto Pilas	7,000	1,400	50,400	72,000
4	Tajibo	2,000	120	12,000	25,920
5	Tarope	1,170	184	19,800	32,040
6	Bisito	2,100	500	18,000	54,000
7	Don Lorenzo	5,000	833	67,200	89,960
8	La Barranca	500	100	7,200	72,000
9	Villa Alba	500	90	3,120	12,960

(source: Interview survey with rural water supply management committees)

2. Building a business model and developing a business plan

2.1 Building a BOP business model

(1) Business model

Concept of the basic BOP business model is as shown in Figure-2.1. Ultimate goal of this project is to make the management basis of community-based rural water supply system stable and sustainable through the BOP business. For that purpose, it is the goal of the BOP business to make the business successful combining the interest of village people who are willing to develop a new productive activity such as aquaculture with the knowledge and skills of the business proposer.

It should be an essential structure of the BOP business model that the whole aquaculture production system is divided into two major groups. One group is “Aquaculture units” which are operated and managed by BOP communities based on villages, and the other is “Core operating company” which is located in large consumption area and operated/managed by the business proposer. The core operating company should intensively increase production efficiency by controlling quality/risks and reducing costs

In selected nine villages, the rural water supply management committee should be the core of the group and organize an aquaculture association to make it an aquaculture unit. The aquaculture units should cultivate fish, Pacu, from fry to grown fish according to the agreement with the core operating company. The core operating company should purchase fry and feed by bulk, monitor the growth of fish, provide the aquaculture units proper quality/quantity of safe feed at proper timing, and provide regular/irregular technical guidance.

Grown fish are shared out half-and-half to the aquaculture units and the core operating company. The aquaculture units directly sell the products by their own way (for example, by fresh fish or by cooked fish as the existing fish farmers do) to neighboring residents or recreation guests from urban area. The aquaculture units gain a profit deducting consumables costs and personnel expenses from the net sales. The unit put the profit into the revenue of the rural water supply management committee, and devote it to operation/maintenance costs of rural water supply systems.

The core operating company receives 50% of cultivated fish from the aquaculture unit as a reward for fry, feeds and technical guidance. The company stocks the received fish for a week farming the fish without feeds and removing smell and mud from the fish. After the stocking process, the fish are processed, frozen and stored as products. After that, the products are shipped and sold to restaurants or retail stores in Santa Cruz City. And the company gains a profit.

At the initial stage, the amount of profit gained by the sales of fish received from all units is not much enough to maintain the business. Therefore the core operating company owns ten ponds, cultivates fish from fry to grown fish there and covers the shortage. In addition, various experiments and researches on aquaculture can be carried out using these own ponds, and the results can also be utilized for technical guidance to the aquaculture units.

(2) Business strategy

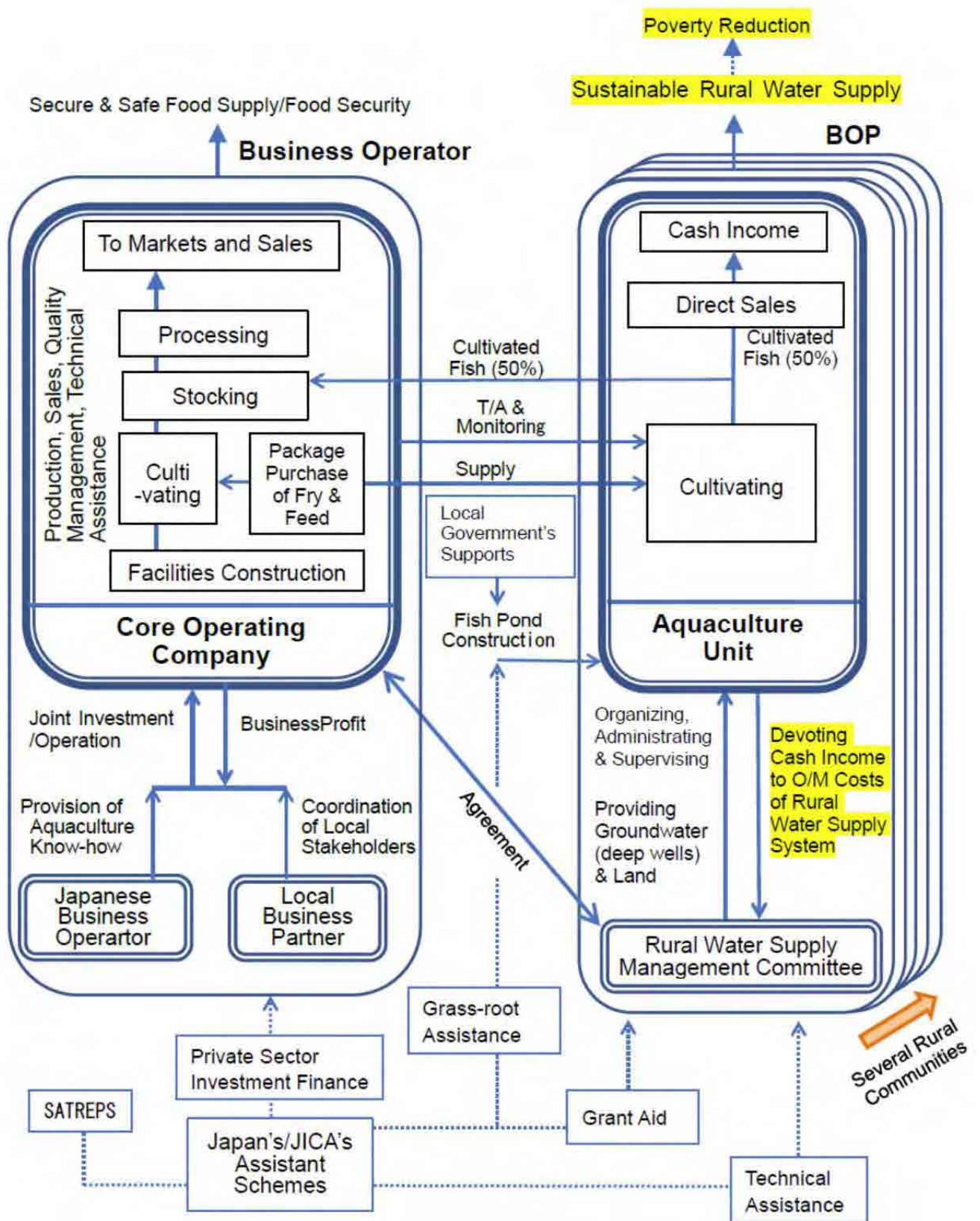
In the BOP business, the core operating company has to bring a stable harvest to the aquaculture units by providing a proper technical guidance for water pollution control, disease prevention, efficient feeding and countermeasures against low temperature, and also has to stably bring a profit to the units. The package purchase of fry and feeds by the core operating company reduces not only financial burden of the aquaculture units for initial costs but also material costs. It brings better profitability to the units than that of individual operation by BOP group.

Above-mentioned thing depends on the supposition that the core operating company gains a stable profit. Therefore, the company should improve the taste at the stocking process by farming fish without feed and removing smell and mud from the fish, and should maintain high freshness by processing the fish properly. Thus the company enhances the added value of the products and sells them to restaurants that require high quality of food. Finally the company can promote the differentiation of other suppliers and can win the competition with other suppliers.

The core operating company does not receive and sell all grown fish from the aquaculture units or does not allocate the profit to the units. Because the units can enhance the motivation and ownership for the business by selling the fish they cultivated. In fact, existing fish farming communities have started selling fresh fish at the retail stores or serve the cooked fish to the guests who come from urban area for a harvest festival or a periodic market. They are interested in selling the products by themselves and earning cash.

As the business deals with living creatures as products, it is expected that some things do not carry on as planned. Therefore the minimum basic unit of the business model should be determined and launched at the initial stage, and the basic unit would be gradually expanded twice and three times.

The minimum basic unit should be composed of nine aquaculture units ($1,000\text{m}^2 \times 1\text{pond} + 2,000\text{m}^2 \times 17\text{ponds}$) and the core operating company. Based on the actual result of the first three years, the scale of operation will be expanded to double or triple after the fourth year. The expansion of the scale of operation will be realized by both horizontal and vertical ways. The scale of operation will expand horizontally when new villages join the business, and vertically when the production capacity of the aquaculture unit is improved.



Figure—2.1 Conceptual figure of the BOP business model

2.2 Business plan

(1) Product development

1) Outline from cultivating to selling Pacu

As shown in Figure-2.2, the core operating company supplies fry and feeds at its discretion to each aquaculture unit, carries out periodical monitoring, provides technical guidance or consultation and receive 50% of grown fish as a reward from the unit. Received fish are stocked for a week to improve the taste. After the stocking, they are processed, frozen, shipped and sold. Fish cultivated in the company's own ponds are also treated in the same manner.

2) Fish species for aquaculture

The following three species are commonly known as “Pacu” and easily available in Santa Cruz. So Pacu is adopted for the BOP business.

- ① **Tambaqui:** *Piaractus brachypomus* (scientific name), the Amazon basin (place of origin)
- ② **Pacu:** *Colossoma macropomum* (scientific name), the Amazon basin (place of origin)
- ③ **Tambacu:** A crossbred of Tambaqui (♀) and Pacu (♂) [*Piaractus mesopotamicus* (scientific name), Plata River basin (place of origin)]

3) Basic cultivation process per pond of the aquaculture unit

A major facility of the aquaculture unit is an aquaculture pond 80m long and 25m wide. Then the standard area is $25\text{m} \times 80\text{m} = 2,000\text{m}^2$, and the standard shape is shown in Figure – 2.3. The standard depth is 2.5 -3.0m with the freeboard of 1.0m. The freeboard is designed to protect fish from cold-weather damage. Just prior to winter season, the freeboard is filled with water and it prevents the drop in temperature from transferring to inside of the pond.

Basic conditions for the production process of the

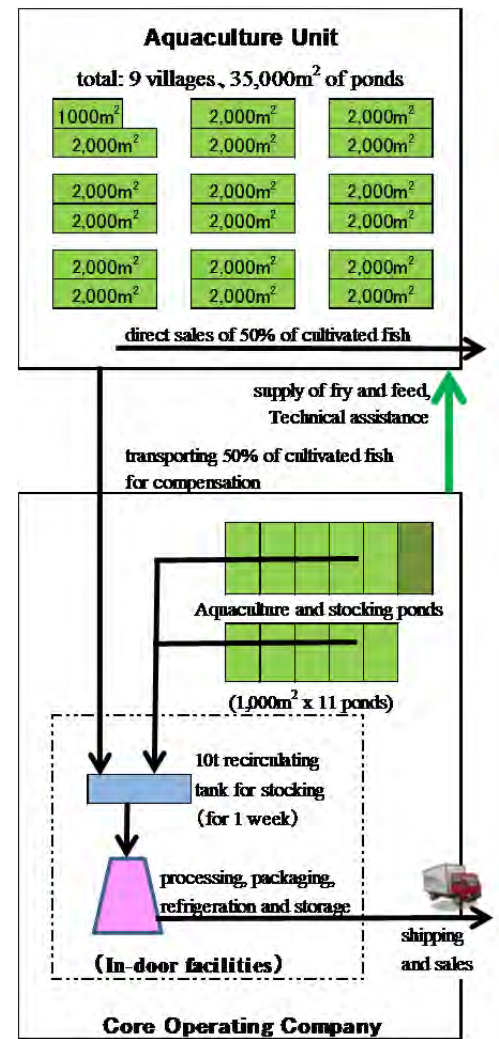
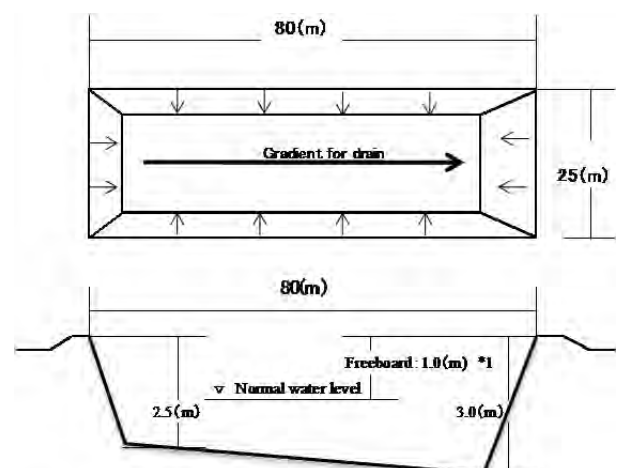


Figure – 2.2 Production Flow



* 1 : to increase water level as countermeasures against the decline of water temperature

Figure – 2.3 Standard figure of aquaculture unit's pond

aquaculture unit are as follows;

- ① One production cycle is three years from planting fry in the first year until drying and disinfection in the third year,
- ② Since an average growth rate of Pacu is 100g/month, Pacu grows to 1.2kg in 12 months after planting fry,
- ③ Since possible density of planting fry is 1fry/m², maximum biomass in the pond should be determined referring to the value of 0.5 - 0.6kg/m²,
- ④ In the sixth month since planting fry, fish of around 0.5kg are harvested intermediately,
- ⑤ Fish are finally harvested during the three months between 12 months and 15 months after planting fry (fish of average weight 1.2 - 1.5kg), and
- ⑥ The core operating company provides each aquaculture unit monitoring and technical guidance such as water quality/quantity management as well as fry and feeds. As a reward for the assistance, each aquaculture unit provides 50% of the harvest to the core operating company. Each unit also sell the remaining 50% of the harvest by himself.

Fish harvested from each standard pond (2,000m²) during a standard production cycle of three years are estimated as shown in Table-2.1.

Table—2.1 The unit's harvest plan of the standard production cycle for an aquaculture unit's pond (1 pond: 2,000m²)

Year	Month	Rearing ①, ③		Rearing ②		Event	for Direct sales		for Transport to the core operating	
		ave weight	nos of fish	ave weight	nos of fish		nos of fish	weight (kg)	nos of fish	weight (kg)
1st	1	①-5g	2,000			Planting Fry ①				
	2	↓	2,000							
	3	↓	2,000							
	4	↓	2,000							
	5	↓	2,000							
	6	0.5kg	1,000			Intermediate harvest ①	500	250	500	250
	7	↓	1,000							
	8	↓	1,000							
	9	↓	1,000							
	10	↓	1,000							
	11	↓	1,000							
	12	1.2kg	800			Harvest ①			100	120
2nd	1	1.3kg	600	②-5g	2,000	Planting fry ② (in the floating cage)	500	(*)1 690	100	130
	2	1.4kg	400	↓	2,000	Harvest ①			100	140
	3	1.5kg	0	↓	2,000	Final harvest ①			200	300
	4			↓	2,000	Removal of the floating cage ②				
	5			↓	2,000					
	6			0.5kg	1,000	Intermediate harvest ②	500	250	500	250
	7			↓	1,000					
	8			↓	1,000					
	9			↓	1,000					
	10			↓	1,000					
	11			↓	1,000					
	12			1.2kg	800	Harvest ②			100	120
3rd	1	③-5g	2,000	1.3kg	600	Planting fry ③, Harvest ②	500	690	100	130
	2	↓	2,000	1.4kg	400	Harvest ②			100	140
	3	↓	2,000	1.5kg	0	Final harvest ②			200	300
	4	↓	2,000			Removal of the floating cage ③				
	5	↓	2,000							
	6	0.5kg	1,000			Intermediate harvest ③	500	250	500	250
	7	↓	1,000							
	8	↓	1,000							
	9	↓	1,000							
	10	↓	1,000							
	11	1.1kg	1,000			Harvest for the core operating company			500	550
	12		0			Fry harvest ③, Drying and disinfection	500	550		
Total harvest for 3 years							3,000	1,990	3,000	2,680
Average annual harvest							1,000	663	1,000	893
Remarks: Harvest of 1,000m ² pond							500	332	500	447

(*)1) The same as the total weight of 4 months harvests for the core operating company

4) Production plan for all aquaculture units and the share taken by the core operating company

Production plan for all nine aquaculture units or the share taken by the core operating company are estimated based on the above-mentioned unit's harvest plan taking the following conditions into account.

- ① The proper period for planting fry into the ponds of aquaculture units is December to April when fry are easily available,
- ② The total area of ponds of all nine units is 35,000m².

The results of the estimation are shown in Table-2.2. The total amount of the share taken by the core operating company is 15.6t/yr. (17,500fish). The fish received from each unit are packed in a simple 1m³ tank and transported to the core operating company by truck.

Table—2.2 Harvest plan of the standard production cycle for all aquaculture units' ponds (9 villages, 18 ponds of 35,000m² total area)

Year	Unit	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	Harvest plan of the whole aquaculture units for direct sales (= The share taken by the core operating company)							
											0.5kg		1.1-1.5kg		Total			
											nos. of fish	Weight (kg)	nos. of fish	Weight (kg)	nos. of fish	Weight (kg)		
	Pond area x nos.	2,000m ² x 1000m ²	2,000m ² x 2 ponds	2,000m ² x 2 ponds	2,000m ² x 2 ponds	2,000m ² x 2 ponds	2,000m ² x 2 ponds	2,000m ² x 2 ponds	2,000m ² x 2 ponds	2,000m ² x 2 ponds								
	Total area	3,000(m ²)	4,000(m ²)	4,000(m ²)	4,000(m ²)	4,000(m ²)	4,000(m ²)	4,000(m ²)	4,000(m ²)	4,000(m ²)								
1	JAN	5g					5g										0	
	FEB		5g														0	
	MAR			5g						5g							0	
	APR				5g												0	
	MAY																0	
	JUN	0.5kg					0.5kg					1,750	875				1,750	875
	JUL		0.5kg					0.5kg				2,000	1,000				2,000	1,000
	AUG			0.5kg						0.5kg		2,000	1,000				2,000	1,000
	SEP				0.5kg						0.5kg	2,000	1,000				2,000	1,000
	OCT																0	0
	NOV																0	0
	DEC	1.2kg					1.2kg							350	420	350	420	4,295
	2	JAN	1.3kg	1.2kg				1.3kg	1.2kg						750	935	750	935
FEB		1.4kg	1.3kg	1.2kg			1.4kg	1.3kg	1.2kg					1,150	1,490	1,150	1,490	
MAR		1.5kg	1.4kg	1.3kg	1.2kg		1.5kg	1.4kg	1.3kg	1.2kg				1,900	2,610	1,900	2,610	
APR			1.5kg	1.4kg	1.3kg			1.5kg	1.4kg	1.3kg				1,600	2,280	1,600	2,280	
MAY				1.5kg	1.4kg	0.5kg			1.5kg	1.4kg		1,000	500	1,200	1,760	2,200	2,260	
JUN		0.5kg			1.5kg		0.5kg			1.5kg		1,750	875	800	1,200	2,550	2,075	
JUL			0.5kg					0.5kg				2,000	1,000			2,000	1,000	
AUG				0.5kg					0.5kg			2,000	1,000			2,000	1,000	
SEP					0.5kg					0.5kg		2,000	1,000			2,000	1,000	
OCT																0	0	
NOV							1.2kg							200	240	200	240	
DEC		1.2kg					1.3kg	1.2kg						550	680	550	680	
3		JAN	1.3kg	1.2kg			1.4kg	1.3kg	1.2kg						950	1,215	950	1,215
	FEB	1.4kg	1.3kg	1.2kg		1.5kg	1.4kg	1.3kg	1.2kg					1,550	2,090	1,550	2,090	
	MAR	1.5kg	1.4kg	1.3kg	1.2kg		1.5kg	1.4kg	1.3kg	1.2kg				1,900	2,610	1,900	2,610	
	APR		1.5kg	1.4kg	1.3kg			1.5kg	1.4kg	1.3kg				1,600	2,280	1,600	2,280	
	MAY			1.5kg	1.4kg	0.5kg			1.5kg	1.4kg		1,000	500	1,200	1,760	2,200	2,260	
	JUN	0.5kg			1.5kg		0.5kg			1.5kg		1,750	875	800	1,200	2,550	2,075	
	JUL		0.5kg					0.5kg				2,000	1,000			2,000	1,000	
	AUG			0.5kg					0.5kg			2,000	1,000			2,000	1,000	
	SEP				0.5kg					0.5kg		2,000	1,000			2,000	1,000	
	OCT															0	0	
	NOV	1.1kg					1.2kg	1.1kg						1,950	2,165	1,950	2,165	
	DEC	Drying	1.1kg			1.3kg	Drying	1.1kg						2,200	2,460	2,200	2,460	
	4	JAN	Drying	Drying	1.1kg	1.4kg		Drying	Drying	1.1kg					2,400	2,800	2,400	2,800
FEB			5g	Drying	1.1kg	1.5kg			Drying	1.1kg				2,400	2,800	2,400	2,800	
MAR					5g	Drying	1.5kg			5g						0	0	
APR						5g				5g						0	0	
MAY							0.5kg				1,000	500			1,000	500		
JUN		0.5kg					0.5kg				1,750	875			1,750	875		
JUL			0.5kg					0.5kg			2,000	1,000			2,000	1,000		
AUG				0.5kg					0.5kg		2,000	1,000			2,000	1,000		
SEP					0.5kg					0.5kg		2,000	1,000			2,000	1,000	
OCT							1.1kg						1,000	1,100	1,000	1,100		
NOV							Drying								0	0		
DEC		1.2kg					1.2kg						350	420	350	420		

NOTE:
 No.1: Clara San Pedro, No.2-No.9: other 8 villages
 5g: Planting fry 0.5kg: Intermediate harvest
 1.1-1.5kg: Final harvest Drying: Drying and disinfection of pond

Total harvest for 3 years	26,250	13,125	26,250	33,775	52,500	46,900
Average annual harvest	8,750	4,375	8,750	11,258	17,500	15,633
Average monthly harvest	729	365	729	938	1,458	1,303

5) Production plan for own ponds of the core operating company

As shown in Table-2.3, the total amount of harvest for ten own ponds is estimated to be 9.4t/yr. when a standard pond of 1,000m² brings 940kg/yr. of harvest to the core operating company.

Table—2.3 Harvest plan of the core operating company's own ponds

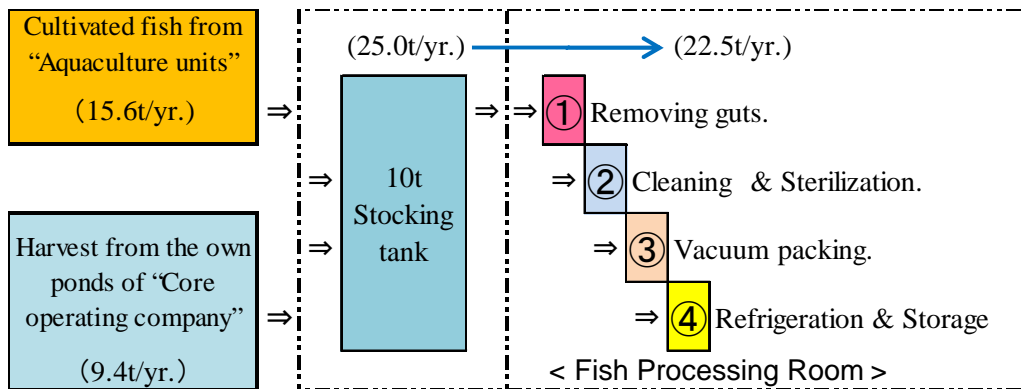
Year	Pond	No.1, 2		No.3, 4		No.5, 6		No.7, 8		No.9, 10		No.11 1,000m ² Stocking pond	Harvest of own ponds								
		Total area		2,000(m2)		2,000(m2)		2,000(m2)		2,000(m2)			2,000(m2)		0.5kg*		1.1-1.5kg		Total		
		Month of planting fry		1月		2月		3月		4月			12月		nos. of fish	weight (kg)	nos. of fish	weight (kg)	nos. of fish	weight (kg)	
1	JAN																		0		
	FEB																		0		
	MAR																		0		
	APR																		0		
	MAY																		0		
	JUN	0.5kg	1,000											1,000	500				1,000	500	
	JUL			0.5kg	1,000									1,000	500				1,000	500	
	AUG					0.5kg	1,000							1,000	500				1,000	500	
	SEP							0.5kg	1,000					1,000	500				1,000	500	
	OCT																		0	0	
	NOV																		0	0	
	DEC	1.2kg	200															200	240	200	240
2	JAN	1.3kg	200	1.2kg	200													400	500	400	500
	FEB	1.4kg	200	1.3kg	200	1.2kg	200											600	780	600	780
	MAR	1.5kg	400	1.4kg	200	1.3kg	200	1.2kg	200									1,000	1,380	1,000	1,380
	APR			1.5kg	400	1.4kg	200	1.3kg	200									800	1,140	800	1,140
	MAY					1.5kg	400	1.4kg	200	0.5kg	1,000		1,000	500	600	880	1,600	1,380			
	JUN	0.5kg	1,000					1.5kg	400				1,000	500	400	600	1,400	1,100			
	JUL			0.5kg	1,000								1,000	500			1,000	500			
	AUG					0.5kg	1,000						1,000	500			1,000	500			
	SEP							0.5kg	1,000				1,000	500			1,000	500			
	OCT																		0	0	
	NOV										1.2kg	200					200	240	200	240	
	DEC	1.2kg	200								1.3kg	200					400	500	400	500	
3	JAN	1.3kg	200	1.2kg	200					1.4kg	200						600	780	600	780	
	FEB	1.4kg	200	1.3kg	200	1.2kg	200			1.5kg	400						1,000	1,380	1,000	1,380	
	MAR	1.5kg	400	1.4kg	200	1.3kg	200	1.2kg	200								1,000	1,380	1,000	1,380	
	APR			1.5kg	400	1.4kg	200	1.3kg	200								800	1,140	800	1,140	
	MAY					1.5kg	400	1.4kg	200	0.5kg	1,000		1,000	500	600	880	1,600	1,380			
	JUN	0.5kg	1,000					1.5kg	400				1,000	500	400	600	1,400	1,100			
	JUL			0.5kg	1,000								1,000	500			1,000	500			
	AUG					0.5kg	1,000						1,000	500			1,000	500			
	SEP							0.5kg	1,000				1,000	500			1,000	500			
	OCT																		0	0	
	NOV										1.2kg	200					200	240	200	240	
	DEC	1.2kg	200								1.3kg	200					400	500	400	500	
4	JAN	1.3kg	200	1.2kg	200					1.4kg	200						600	780	600	780	
	FEB	1.4kg	200	1.3kg	200	1.2kg	200			1.5kg	400						1,000	1,380	1,000	1,380	
	MAR	1.5kg	400	1.4kg	200	1.3kg	200	1.2kg	200								1,000	1,380	1,000	1,380	
	APR			1.5kg	400	1.4kg	200	1.3kg	200								800	1,140	800	1,140	
	MAY					1.5kg	400	1.4kg	200	0.5kg	1,000		1,000	500	600	880	1,600	1,380			
	JUN	0.5kg	1,000					1.5kg	400				1,000	500	400	600	1,400	1,100			
	JUL			0.5kg	1,000								1,000	500			1,000	500			
	AUG					0.5kg	1,000						1,000	500			1,000	500			
	SEP							0.5kg	1,000				1,000	500			1,000	500			
	OCT																		0	0	
	NOV										1.2kg	200					200	240	200	240	
	DEC	1.2kg	200								1.3kg	200					400	500	400	500	

1.2kg 200 : Drying and disinfection of a pond is done at the end of the 3rd year for each pond. (Fish will be transferred in the stocking pond during the period.)

6) Plan for stocking by the re-circulating system and processing

The total of the amount of 15.6t/yr. (17,500 fish) received from the aquaculture units and the amount of 9.4t/yr. (10,000 fish) harvested from own ponds is 25.0t/yr. (27,500 fish). As shown in Figure-2.4, fish are processed after stocking to add value to the products. Fish are stocked for a week in 10t re-circulating tank installed in the building of the core operating company, and after that fish are captured, and transferred to the processing room.

In the processing room, i) guts are removed from fish (losing weight by 10%), ii) fish are washed, sterilized, iii) vacuum packed, iv) put a seal with the date of processing, v) frozen and stored in the freeze; and the products (22.5t/yr.) are completed 12 hours later.



Figure—2.4 Flow of production processes from cultivation to processing

(2) Procurement of equipment and materials

1) Fry and feeds

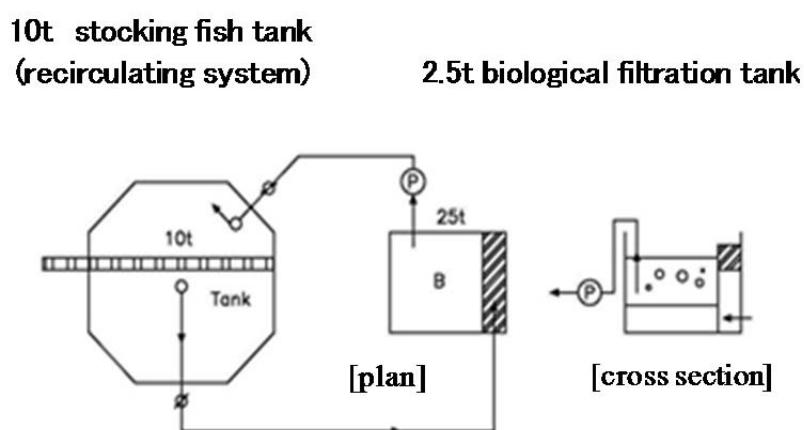
Fry and feeds are procured in Santa Cruz Prefecture and Beni Prefecture. Manufacturers of feed sell fry as well. General size of fry is 3–5g, and they are supplied from December to April. Manufacturers produce and sell feeds adjusting them to the growth of fish. Some manufacturers supply the feeds with moderate prices for a bulk purchase. Fry can be purchased at Bs.1.4/kg and feed at Bs.3.7/kg.

It is said that the FCR (food conversion ratio) of Pacu is 1.8-2.0 generally. According to the results of interview with the aquaculture experts of local university and NGO and the fish farmers, FCR=1.8 is possible if feeding volume can be adjusted based on everyday monitoring of actual situation of taking feed. Therefore FCR=1.8 is applied for the business.

(3) Facilities plan of the core operating company

Facilities or equipment necessary for the core operating company are described below.

- 1) Indoor recirculating tank for stocking fish (The conceptual figure is shown in Figure-2.5)
- 2) Equipment for processing fish
- 3) Equipment for test and inspection
- 4) Building for facilities and equipment (total area: 480m²)
- 5) Heavy equipment
- 6) Own aquaculture ponds and stocking pond (20m x 50m=1,000m², depth:2.5-3.0m, nos:10 for cultivation and 1 for stocking)
- 7) Water supply facilities



Figure—2.5 Conceptual figure of indoor recirculating system

(4) Shipping and sales plan of the core operating company

The products are mainly sold to restaurants and supermarkets in Santa Cruz City. It will be stressed that the products are high-quality, free from smell and quite different from those harvested by ordinary fish farms.

(5) Staffing and human resource development

At least one full-time aquaculture expert is employed by the core operating company to properly manage cultivating, providing a technical guidance to the aquaculture units, processing and shipping.



Figure—2.6 Image of the product

The main work of the core operating company are management of own ponds and operations of processing room. Totally 27,500 fish are processed a year including both harvests of the aquaculture units and the company's own ponds. In other words, at least three part-time workers are required for the work.

(6) Business partner and cooperative NGO

1) Business partner

Name : SUIGEN limited liability company
Year of establishment : Year 2007
Business activities : Engineering design, construction, consulting services, trade
Annual sales : USD570,000 (Bs. 3,980,000) (Average of yr.2009-2011)

2) NGO to cooperate with

Name : HOYAM MOJOS
Activities : The headquarters is in Spain, and the Bolivian branch office is in Trinidad City, Beni Prefecture. It was established in September 2003. It is formally operated, and conducting aquaculture projects in Santa Cruz Prefecture and Beni Prefecture.

(7) Project costs of the core operating company

The construction costs of the core operating company are estimated based on the facilities plan and the unit prices for construction. As shown in Table-2.4, the total cost amounts to Bs.1,109,980. The operation costs are shown in Table-2.5.

Table—2.4 Construction costs for facilities of the core operating company

Item	Amount (Bs.)
Supply and Installation Works for the stocking tanks and equipment	68,460
Civil works for the stocking tanks	28,380
Equipment for the fish processing	201,170
Test/inspection equipment	51,400
Building costs	297,070
Heavy equipment	210,000
Civil works for aquaculture and stocking ponds	117,000
Water supply tank and solar panels	115,500
Well-drilling costs	21,000
Total	1,109,980

(8) Financial analysis

1) Business manner

The core operating company runs the business by the following manner.

a) The aquaculture units of nine villages cultivate Pacu using fry, feeds and technical guidance

provided by the core operating company. The units bear consumables costs and personnel expenses for members of fish farmers association who work for feeding or management. The units allocate 50% of the harvests to the core operating company as a reward, sell the remaining 50% of the harvest by themselves and gain a profit.

- b) Each aquaculture units cultivates Pacu in the existing pond or newly constructed pond. The members of fish farmers association construct the pond by themselves using construction equipment borrowed at no charge from the municipality Cotoca. Therefore it is considered that the construction costs for the units' ponds are excluded from any initial investments.
- c) The core operating company bears the costs when the company receives 50% of the harvest and transports them from each unit to the company.
- d) As an initial investment to the core operating company, only the initial costs exclusively necessary for the company are included.

2) Initial investment

The initial investment amount for the core operating company is the facilities construction costs of Bs.1,110,000 (USD164,200).

3) Annual sales amount

- a) The minimum cycle of the cultivation from planting fry until harvest is not a year but 15 months. Drying and disinfection of ponds are carried out every three years. Therefore, as shown in Table-2.2 and Table-2.3, it takes three years to reach the planned production amount, and even after three years, the annual production amount fluctuates in three-year cycle. Adding the harvest received from the aquaculture units and that from the own ponds, and considering the weight loss of 10% by the processing, the annual sales of the core operating company is 5.9t/yr. for the first year, 21.7t/yr. for the second year and 22.5t/yr. for years after the second year. For convenience of the analysis, the average value is used for years after the second year.
- b) Current unit selling price for Pacu at the public markets is Bs.40-60/kg in the year 2012. It is assumed that the unit selling price of Bs.40-60/kg corresponds to the wholesale value in Santa Cruz City.
- c) The above-mentioned annual sales amount is estimated multiplying the unit selling price by the annual sales volume.

4) Annual operation costs

As shown in Table-2.5, the annual operation cost (cost of goods sold) of the core operating company is estimated to be Bs.563,238 (USD83,320) which includes material costs, personnel expenses and utility costs.

5) Year Plan

Although it would be expected that the scale of each unit's operation expands in the period of 10 years, it is assumed for convenience of the analysis that the scale of the operation will not expand within the period.

Table—2.5 Breakdown of operation costs of the core operating company

■ Cost of goods sold			(Unit Price)	Remarks
Material costs				
Cost of supplying fry for the aquaculture units	53,900		2,200fry/2,000m ² (1.4 Bs/fry.)	Total pond area=35,000m ²
Cost of supplying feeds for the aquaculture units	208,171	(FCR=1.80)	3,215kg/2,000m ² (3.7 Bs/kg)	
Cost for cultivating own ponds of the core operating company	99,400	nos. of 1,000m ² ponds	10 (ponds) (9,940 Bs/pond)	
Salt, nitrifying bacteria, etc.	9,600		(800 Bs/month)	
Subtotal	371,071			
Personnel expenses				
Expert (full-time)	60,000	nos.:	1 person (5,000 Bs/month)	
Worker (part-time)	72,000	nos.:	3 persons (2,000 Bs/month)	
Subtotal	132,000			
Utility costs				
Electricity	24,007	8.7kw×24h×365days×50%	(0.63 Bs/kwh)	
Energy cost for heating	675	Annual usage: 1kg/hr.*10hrs.*30days	(22.5 Bs/10kg)	Propane gas
Subtotal	24,682			
Other costs				
Material for shipping and transport	22,530	Cartons, bags for vacuum pack, etc.	(1.0 Bs/kg)	
Consumables	1,200	Reagents for tests and inspections, etc.	(100 Bs/month)	
Maintenance costs	205	0.3% of the construction cost of the stocking fish tanks and equipment		
Rental cost for heavy equipment	11,550	Truck and forklift	(11,550 Bs/yr.)	
Subtotal	35,485			
TOTAL	563,238			

6) Business income and expenditure

Based on the above-mentioned and the following conditions, the business income and expenditure at the selling price of Bs.48/kg are predicted. The results are shown in Table-2.6.

- The initial investment is completed before the start of the first year operation.
- The business period after the start of production is assumed to be 10 years (like depreciation period).
- The annual income is to be the net income after deducting tax from the operating income (corporate tax rate: 25% of ordinary income).

Table—2.6 Possible business income and expenditure of the core operating company (in the case of selling price of Bs.48/kg)

Item	Year									
	1	2	3	4	5	6	7	8	9	10
Selling fish (t/yr.)	5.9	21.7	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Sales(1,000Bs.)	282	1,043	1,081	1,081	1,081	1,081	1,081	1,081	1,081	1,081
Cost of goods sold (1,000Bs.)	563	563	563	563	563	563	563	563	563	563
Gross profit (1,000Bs.)	-281	480	518	518	518	518	518	518	518	518
Operating income (1,000Bs.)	-527	234	272	272	272	272	272	272	272	272
Net income (1,000Bs.)	-527	176	204	204	204	204	204	204	204	204
Accumulated profit (1,000Bs.)	-527	-352	-148	56	260	464	668	872	1,077	1,281

7) Prediction of internal rate of return (IRR)

IRRs are predicted based on the business income and expenditure of different unit selling price. The results are shown in Table-2.7.

Table—2.7 Predicted IRR of different unit selling price

Unit selling price (Bs./kg)	40	45	48	49	50	55	60
IRR(%)	0.2	7.9	11.9	13.2	14.4	20.2	25.5

8) Evaluation of profitability

- a) According to the statistics (year 2007-2011) of National Bank of Bolivia, current lending rate of commercial banks in Bolivia is; 11.20-18.10%/yr. (12.89%/yr. in year 2011) for lending period of more than three years or 6.16-10.86%/yr. (6.65%/yr. in year 2011) for lending period of 0.5-1 year. If IRR is more than the above lending rate, it is generally said that the project is feasible. According to the criteria, the business can be feasible if the unit selling price exceeds Bs.48/kg.
- b) According to Table-2.6, if the unit selling price is Bs.48/kg, the net income of a single year is a positive in the second year, the cumulative deficit is eliminated in the fourth year, and the initial investment (Bs.1, 110,000) can be collected in the 10th year.
- c) If the selling unit price is less than Bs.48/kg, further efforts are required to increase profit by reducing the production costs. In this case, reduction of feeding costs which account for nearly 40% of the production costs is essential. It is necessary to lower the cost of purchasing feeds or to increase the feeding efficiency (in other words, to decrease FCR) by further control of feeding. In addition, it is also required to reduce the funding costs by reducing the debt ratio from banks or by utilizing a soft loan system.
- d) According to the statistics of INE and IMF, the economic growth rate of recent ten years (2003-2012) is 4.5% on average, the inflation rate is 5.8%. On the other hand, the price of fish has risen about 1.9 times (2008 - 2012) for four years (at the rate of 17%/yr. on average) in the statistical data of INE. If this trend is to remain as it is, it would be possible that the increase rate of fish price exceeds the inflation rate and the profitability does not decline.

9) Business income and expenditure of the aquaculture units

Business income and expenditure of the aquaculture units and contribution to BOP group brought by this BOP business are as follows.

Under the following conditions, business income and expenditure of each aquaculture unit (standard facilities: 2,000 m²×2ponds=4,000 m²) are estimated as shown in Table-2.8. Each unit gains gross profit of Bs.22,200/yr./unit.

- a) 50% of harvested Pacu is shared out to the core operating company as a reward for fry, feeds and technical guidance. The company bears the cost to transport Pacu from each unit to the

company.

- b) The aquaculture units sell the remaining 50% of Pacu by themselves at the unit price of Bs.30/kg or more. According to the interview survey carried out in 2012, the existing community-based fish farms sell their fresh fish at the unit price of Bs.30-35/kg and cooked fish at double (Bs.60-70/kg).
- c) The units do not employ a full-time worker. Instead of that, members of the aquaculture association operate or manage the fish farm. The personnel expenses is paid those members in proportion to working hours for feeding or watching.
- d) Consumables (fish net, etc.) costs are included in the costs of the aquaculture units.

Table—2.8 Possible business income and expenditure per aquaculture unit

Item	Amount (Bs.)	Remarks
■Initial investment	0	The cost of fry and feed (Bs.29,950) and the personnel expenses of technical assistance(Bs.2,700) are born by the core operating company. The aquaculture units share out 50% of their harvest to the core operating company as compensation.
■Sales	48,240	fresh Pacu (frozen, round)
		Selling fish Selling price Nos. of ponds(2,000m ²) $804 \text{ kg/pond} \times \text{Bs.30 /kg} \times 2 \text{ ponds}$ Considering removal of guts which weighs about 10% of the whole fish, 90% of harvest is counted as products. (In other words, the sales (804 kg/pond) is equivalent to 90% of the harvest (893 kg/pond).)
■Cost of goods sold	26,040	
Consumables	16,540	Fishing net, etc.
Personnel expense	9,500	950 man-hours
■Gross profit	22,200	

1 0) Contribution to villages and BOP groups

- a) The amount of profit, Bs.22,200/yr./unit, exceeds the ordinary maintenance costs for rural water supply. If a water supply management committee implement the business, the profit from the business directly contributes to operation and maintenance of the rural water supply system. Furthermore it is expected that stable water supply contributes very much to increase of agricultural production or improvement of rural living standards.
- b) With regard to the existing community-based aquaculture, village people organize a management association, and members of the association operate and maintain the facilities as a side job. An average working hours necessary for a standard aquaculture unit is estimated to be 950 man-hours/yr. It means that at least four members can well operate and maintain two fish farming ponds in shifts and full-time workers are unnecessary. Thus association members

who work for the business can receive cash as labor compensation and can improve their income.

(9) Fund raising plan

Outline of fund raising for the core operating company is planned as follows. At the initial stage, financing is reduced as much as possible considering unexpected risks. It is a basic plan that 60% of the fund is raised from own resources and the remaining 40% is borrowed from local banks. The fund is raised in the following allocation, by Earth System Science Co., Ltd. of the Japanese side and by SUIGEN L.L.C. of the Bolivian side.

< Core operating company >

Amount of fund : USD250,000 (Japanese side : USD180,000, Bolivian side : USD70,000)

Breakdown: Initial investment (Facilities construction, Equipment) : USD165,000

Operation costs : USD85,000

Total USD250,000

The local partner, SUIGEN L.L.C., provides their own land as an investment for aquaculture ponds and building of the core operating company.

(1 0) Risk management

Against cold-weather, the farming ponds of the aquaculture units and the core operating company are designed to deepen the water more than 2 meters during the wintertime not to conduct low temperature inside. Besides, relatively warm groundwater from deep well is temporarily supplied to the ponds of the core operating company. For the 10t stocking fish tank of the core operating company, heated water is supplied when the rapid temperature decline occurred.

Considering the risks related to diseases or water quality, it is essential to use deep groundwater of good quality for both the aquaculture units and the core operating company. Safe and reliable fry/feeds are selected and procured by a package purchase under the control of the core operating company, which prevent the water of ponds from deteriorating by impurities and bacteria that cause diseases.

(1 1) Approval and license

1) Registration procedure of limited liability company

a) Registration to inland revenue department

Both an original and a copy of the president's IC (identification card), the president's address and a payment certificate of electricity charge by the company newly established should be notified.

b) Registration to FUNDEMPRESA

The procedure should be done in parallel with the registration to inland revenue department.

2) Procedures of business license at the municipality having jurisdiction over the area to be operating

Office rental agreement, relevant documents if the applicant is the owner of the office, valid ID and address of the office should be submitted to the municipality and get a business license

(1 2) Project implementation schedule

The core operating company is going to be established and the business will start in October 2013. By the end of year 2013, procedures of permits and licenses required to implement the business will be completed, and agreement between the aquaculture units and the core operating company will be concluded. Construction of some facilities such as fish farming ponds or water wells have already started to receive fry which will be supplied from December. The core operating company will start purchasing fry and feeds from December 2013, and will start providing them to the aquaculture units in January 2014. The first harvest will be got in the second half of 2014 and processing, shipping and selling will start then.

(1 3) Environmental and social considerations

As unused common lands are provided by villages for fish farming ponds of the aquaculture units, resettlement issues associated with land acquisition will not occur. Water pollution issues must be very minor, because the effluent from fish farming ponds does not occur excluding the case when the ponds are dried up for disinfection every three years. In addition, as the stocking fish tank of the core operating company is operated by re-circulating system, polluted water does not discharge into natural water body or does not make an impact on the surrounding environment.

3. JICA's projects to be implemented coordinating with the BOP business

(1) Japanese ODA scheme and projects that can be cooperation with the BOP business

As shown in Table-3.1, projects are planned and proposed as effective projects to be in cooperation with this business from the viewpoint of development effectiveness.

Table—3.1 Possible ODA projects to be implemented coordinating with the BOP business

Candidate project	Scheme	Target of the project	Purpose	Executing body
Capacity development project for managed-type cultivation of freshwater fish and quality control at poor villages in Santa Cruz Prefecture	Grassroots technical cooperation (Grassroots cooperation and support type)	<ul style="list-style-type: none"> • Aquaculture coaches of Santa Cruz Prefecture and cities • 10 villages in Santa Cruz Prefecture 	Capacity development for managed-type cultivation of freshwater fish and quality control	JICA
Project for assisting construction of aquaculture ponds at poor villages in Santa Cruz Prefecture	Grant assistance for Grass-roots human security projects	10 villages within the prefecture.	Assistance for facilities construction to start aquaculture	The Japanese embassy in Bolivia
Project to improve hygienic conditions of public fish markets		Cotoca city, El Torno city	Improvement of facilities for selling fresh cultivated fish (freezer, etc.)	
Project for supporting technical improvement for cultivating freshwater fish	Dispatch of expert	Aquaculture research facilities of Gabriel René Moreno Autonomous University	Technical Improvement for cultivating freshwater fish	JICA
Research project for an advance of aquaculture technique to cultivate fish that live in upper stream of the Amazon	Science and technology research partnership for sustainable development (SATREPS)	Aquaculture research center of Autonomous University of Beni	Joint research by Japanese and Bolivian universities and research institutes	JST/JICA (JST: Japan science and technology agency)

(2) Prediction of the effect of cooperation

① Extent of the spread of farming business to the village of Santa Cruz prefecture

It is expected that a rapid expansion of the business model to other villages is realized if the project is implemented through the scheme of grassroots technical cooperation. As a criterion to evaluate the effectiveness of cooperation with this BOP business, “Increase in the number of villages which start aquaculture business in cities other than Cotoca City” is proposed.

② Spread of aquaculture skills by proper management

In order to introduce modern skills and management related to aquaculture and to keep improving them constantly, development of scientific, engineering and business administrative background is essential. It is expected that development is realized through the scheme of dispatch of expert and SATREPS. As criteria to evaluate the effectiveness of cooperation with this BOP business, “Increase in the number of seminars held by the prefecture, municipalities and

universities and improvement of the contents of seminars” and “Increase in the number of inquiries about the aquaculture to research institutions such as universities” are proposed.

4. Prediction of development effectiveness and formulating scenario for expression of development effectiveness

(1) Indicators of development challenges to be solved through the BOP business

Development challenge to be solved is to supply safe water stably for poverty reduction which is a national development challenge in Bolivia. It is proposed to take "the rate of compensation for operation and maintenance costs of the rural water supply system allocating the cash income earned through the BOP business" and "the rate of increase in income of village people who are working for the BOP business" as an indicator to evaluate development effectiveness.

(2) Analysis on the baseline data related to the development indicators

For sustainable water supply services, in the village with around 200 households like Tarope, Bs.36,000/ yr. (Bs.20,000 + Bs.16, 000) is necessary as an annual maintenance costs (an ordinary maintenance costs + a reserve for replacement of facilities/equipment). As current revenue from water charges is about Bs.32,000/yr., the annual budget is short by Bs.4,000/yr. Furthermore, considering the increase in population influx into and around Santa Cruz City in recent years, it is believed that demand for new development and expansion of facilities will increase in the future and the shortfall of water charges revenue will be enlarged.

(3) Scenario for expression of development effectiveness after the start of the BOP business

The aquaculture units should be directly managed by fish farmers associations or rural water supply committee, and an agreement on business management should be made with the core operating company. In the agreement, it should be clearly mentioned that the cash income of each aquaculture unit is devoted to the maintenance costs of the water supply committee.

(4) Target of indicators related to development challenges

As for villages with 200 or less households, it is the target that "the rate of compensation for operation and maintenance costs of the rural water supply system allocating the cash income earned through the BOP business" should be 100%. As for villages with households more than 200, it is the target to gradually raise "the rate of compensation for operation and maintenance costs of the rural water supply system allocating the cash income earned through the BOP business" to nearly 100% for the medium/long term by increasing the amount of harvest. In addition, it is the target that "the rate of increase in income of village people who are working for the BOP business" should be 10%.

5. Experimental Cultivation

The following experiments or tests were carried out in the project area during this preparatory survey period in order to obtain knowledge which should be the basis of formulating cultivation plan and business management plan.

(1) Monitoring of the existing nurseries

Monitoring of cultivating Pacu at the existing fish farm, various data such as fish weight, temperature and water quality of the ponds were obtained. Although there was a difference of growth rate between at the first term and at the last term, it is expected that an average growth rate of 100g/month can be achieved if proper operation and control are performed by the technical guidance of the core operation as experts of university and NGO said.

(2) Experiment on carrying density

The transport experiments were carried out by changing the combination of conditions of oxygen supplied and transport density. As a result, no damage or no mortality was found under the condition of both 8.4% of conveyance density without oxygen and 18.3% conveyance density include oxygen. It is confirmed that to transport fish in the box for three hours is possible.

(3) Experimental cultivation using re-circulating aquaculture system

It was confirmed that fry can take feed though farming condition was changed due to a transport from pond to tank. However fish grown to a certain extent did not take feed and lost weight when the fish were put under stress due to change of environment. As it was found difficult to transport fish and increase the weight in a short period, the process of final cultivation for a month was removed from the initial plan.

(4) Taste test

In the evaluation of the odor due to heating by a microwave oven, both group of Japanese Bolivian and Japanese (hereinafter referred to as Japanese Group) and group of non-Japanese Bolivian (hereinafter, referred to as Local Group) felt the sludge smell strongly in the fish farmed in ponds, and 95% of examinee showed discomfort. In the taste evaluation by other recipes, it was found that there is a clear difference between the taste of Japanese Group and that of Local Group. 70-90% of the Japanese Group showed the discomfort and felt a strong odor in the fish farmed in ponds. Japanese Group evaluate appreciated the fish farmed in re-circulating system. On the other hand, Local Group did not show a strong discomfort in the fish farmed in ponds. As for the boiled fish and ceviche, about

half of Local Group like the fish farmed in ponds rather than that farmed in re-circulating system. The fish farmed in re-circulating system seemed to be a little light for Local Group.

(5) Food hygiene inspection for frozen fish

Food hygiene inspection for frozen fish was carried out subcontracting to local inspection organization for five samples such as the fish farmed in re-circulating system, the fish farmed in the existing fish pond or the fish sold in Santa Cruz City. Bacteria of all samples are below the value of frozen food inspection standard of Bolivia.

However careful washing (in the cleaning work after removal of guts, washing carefully to epidermis) reduced the number of bacteria from thousand order to hundred order. Thing in the processing field of the core operating company in this project, hygiene control and thorough hand washing, etc. of workers and washing with sterile water is needed revealed

(6) Tolerance test against a drop in water temperature

According to the observations, decrease in activity of Pacus were observed when air temperature dropped to 19.5 °C, and Pacus grew weak with the growing temperature to drop. When air temperature dropped to 14.5 °C, Pacus stopped activity due to weakness, and finally Pacus went up floating on the surface of the water at 12 °C. After that, Pacus resumed activities when temperature rose up to 23 °C.

In fact, as a fish farming pond has large heat capacity, rapid water temperature reduction as in the experiment is difficult to occur in actual ponds. However, it is better to define water temperature of 16 °C as a criterion to take countermeasures like supplying heat or hot water into ponds or tanks.

(7) Floating efficiency test of feed

Pacu has the habit of taking floating feed but not taking feed depositing to the bottom. It is better for Pacu if feeds suspend longer. Therefore floating efficiency is essential factor for feeding efficiency. Even if feeds are supplied by the same maker, the floating efficiency is dependent on the size. It should be necessary to check the floating efficiency when the feed is purchased or to pay attention to the storage.