DEVELOPMENT OF THE MUD CRAB SECTOR IN THREE PROVINCES OF THE PHILIPPINES
- CONSTRAINTS AND PROSPECTS -

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Defended the : September, 16th 2010

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Nb pages : 47 **Appendix :** 34
Year : 2010

Title : Development of the mud crab sector in the Philippines – constraints and prospects-

Résumé :
La filière du crabe de mangrove (*Scylla sp.*) comprend trois sous-systèmes : la pêche des juvéniles et des adultes dans le milieu naturel, le grossissement ou l'engraissement en étangs ou en enclos et enfin, les circuits de commercialisation dans le marché domestique ou à l'export. L'ensemble du crabe d'aquaculture produit aux Philippines est issu du milieu naturel, les écloseries n'ayant pas été adoptées par le secteur privé à ce jour. Les juvéniles sont pêchés dans la mangrove et transportés jusque dans les zones d'élevage. La production de crabes est de 10 000 tonnes par an, provenant pour une large part de l'élevage. Le principal système de production est la polyculture extensive. Les crabes sont élevés à de faibles densités (<0,1 crabe/m^2) en association avec le chanos (*Chanos chanos*), le tilapia (*Oreochromis spp.*) et éventuellement les crevettes (*Penaeus vannamei* ou *Penaeus monodon*). Si les poissons sont majoritaires en terme de volume, les crustacés assurent l'essentiel du revenu du paysan. Traditionnellement, la crevette représentait 60% du revenu. Aujourd'hui, le crabe représente entre 20 et 30% de la valeur de la production contre 20 à 50% pour la crevette selon son taux de survie. Le crabe est désormais considéré comme une espèce structurante économiquement de la polyculture extensive dans la mesure où le revenu issu de la crevette n'est plus fiable. Le crabe est principalement vendu sur le marché domestique malgré son prix élevé. L'export à destination de Hong Kong, Taiwan et Singapour ne représente que 17% du marché. La contrainte majeure identifiée pour le développement du secteur crabe est l'approvisionnement en juvéniles, la production ne reposant que sur sa récolte dans le milieu naturel. Le stock de crabes montre des signes d'épuisement (réduction du volume et de la taille des captures). Des régulations de la collecte et du transport des juvéniles ont été mises en application mais leur contenu manque de cohérence en lien avec un manque de données biologiques et écologiques sur le crabe. Une autre contrainte majeure identifiée est l'espace étant donné que la conversion de la mangrove en étang a été interdite et que le crabe est élevé à des densités très faibles en étangs. Des sytèmes de culture préservant la mangrove ont été mis au point mais leur extension a visiblement échoué malgré des résultats techniques encourageants. Enfin, le marché domestique semble limité par le prix élevé de ce crustacé tandis que le marché à l'export est fluctuant selon la saison et soumis à la concurrence.

Abstract :
The purpose of the whole mud crab sector is to transform juveniles or low quality adults into marketable crabs for consumption. The mud crab sector involves three sub-sector : the supply of crab seed stock ; grow-out and fattening operations in ponds or pens and finaly marketing channels to the domestic or export market. The major constraint identified for the development sector is the supply of crab juveniles, the production being only based on wild-caught juveniles. The juveniles are collected in the mangrove and transported to producing areas. Mud crab production currently represents 10,000 m. t. mostly coming from culture operations. The main farming system is extensive polyculture. Crabs are stocked at low densities (< 0.1 crab/m^2) and commonly associated with milkfish (*Chanos chanos*), the tilapia (*Oreochromis spp.*) and shrimps (*Penaeus vannamei* or *Penaeus monodon*). If the fish are most important in terms of quantity, crustaceans have a major economic role. Traditionally, shrimp accounted for 60% of the income. Today, the crab represents between 20 and 30% of the value of the production against 20-50% for the shrimp depending on its survival rate. Mud crab is now regarded as a structuring species of farming systems. The shrimp, by the variability of its survival, is no longer a guarantee of the resilience of this culture system. Marketable crabs are mostly sold in the domestic market even though it is highly priced. Export to Hong Kong, Taiwan and Singapore only accounts for 17% of the market. The main constraints identifyed for the development of the sector is the limited supply of crab seed stock. Hatcheries are not an option so far and require further technical improvements. The crab stock is showing signs of depletion (reduction of volume and size of captures). Regulation for the collection and transportation of juveniles have been implemented but their content is inconsistent in relation to a lack of biological and ecological data on mud crabs. Another major constraint identified is the space limitation as the conversion of mangrove pond was prohibited, and because crabs are stocked at very low densities in ponds. Farming systems preserving the mangroves have been developed but their extension has failed, despite encouraging technical results. Finally, the domestic market seems limited by the high price of mud crab while the export market is seasonal and subject to competition.

Mots-clés : Polyculture extensive, crabe de palétuvier, *Scylla spp.*, filière, MAR (Méthode Accélérée de Recherche)

Key-words : Extensive polyculture, mud crab, *Scylla sp.*, value chain analysis, RA (Rapid Appraisal)

Diffusion :
Non limitée
Limitée (préciser au verso)

ACKNOWLEDGMENTS

The present study was realized thanks to the **CIRAD** (French Agricultural Research Center for International Development), the **SEARCA** (Southeast Asian Regional Center for Graduate Study and Research in Agriculture) and the **WorldFish Center**. The three institutions were unified in a EU (European Union) funded project called **FPAVAS** (Focused-Food Production Assistance for Vulnerable Sectors).

Un grand merci à **Pierre MORISSENS** (CIRAD) de m'avoir ouvert la porte de cet archipel aux mille visages : des paysages de cocotiers bicolanos aux étangs infinis de la baie de Manille en passant par les mangroves luxuriantes de Samar, yeux et papilles se sont régalés ! Un pays attachant et parfois troublant pour un jeune chercheur en aquaculture ! Merci d'avoir guidée mes pérégrinations dans les méandres de la recherche et du développement sans jamais imposer. Merci de m'avoir fait partager tes expériences et tes sentiments sur le sujet. Merci à **Dominique OMBREDANE**, **Hervé LE BRIS** et **Thomas EFOLE EWOUKEM** pour m'avoir fait part de leurs commentaires avisés.

Thank you to **Maripaz PEREZ** and **Len GARCES** (WorldFish Center) for giving me a warm welcome and making me feel like I belong to the Philippines Country Office staff. A responsive team always ready to go forward to effectively handle the issues related to fisheries and aquaculture. Not an easy task in such a dynamic and aquatic country !

Thank you to **Bessie BURGOS** (SEARCA, manager of the FPAVAS project) for being always available and attentive during my stay in this endearing country.

Thank you to **Amy LOPEZ** (and the Provincial Government of Camarines Norte), **Tony TEOPE** (and the Municipality of Mercedes) **Veronica LAGUITAN** (and the DOST staff of Northern Samar), **Pepe LUTAO** (and the BFAR of Northern Samar), **Romeo ALBERTO** (and the Municipality of Sasmuan) who helped me and shared with me their life and experience in a way I could never imagine.

Thank you to all the actors of the mud crab industry, it was fascinating to realize how mud crabs connect such a great number of people and such a great diversity. Thank you to the **fishermen**, the **farmers**, the **traders**, the **institutionnal actors** who helped me making my way through this maze. I will not quote all your names but you are well set in my mind.

Thank you to my dear **mud crabs** for being available and so talkative during interviews. I guess I missed some information you gave me considering that I had not always the appropriate decoder !

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GLOSSARY

Advocacy - public support for or recommendation of a particular cause or policy.

Aquaculture - fishery operations involving all forms of raising and culturing fish and other fishery species in fresh, brackish and marine areas (RA8550).

Broker - a person who buys and sells goods or assets for others.

Commercial fisheries - the taking of fishery species by passive or active gear for trade, business or profit beyond subsistence or sports fishing, to be further classified as: (1) Small scale commercial fishing - fishing with passive or active gear utilizing fishing vessels of 3.1 gross tons (GT) up to 20 GT; (2) Medium scale commercial fishing - fishing utilizing active gears and vessels of 20.1 GT up to 150 GT; and (3) Large scale commercial fishing - fishing utilizing active gears and vessels of more than 150 GT (RA8550).

Dealer - a person or business that buys and sells goods.

Development – *(1)* a specified state of growth or advancement *(2)* a new and refined product or idea *(3)* an event constituting a new stage in a changing situation.

Extensive aquaculture – fish production in extensive systems is based on the use of organic and inorganic fertilisers. Fertilisation of ponds promotes the growth of simple plants which form the base of the food chain in the pond. Fish stocked in these ponds feed on phytoplankton, zooplankton, bottom-dwelling invertebrates and smaller fish. At its most effective, this type of production can be integrated with other types of crop or livestock production, using animal manure and agricultural by-products as sources to stimulate primary production.

Fish Cage - stationary or floating fish enclosure made of synthetic net wire/bamboo screen or other sides either tied to poles staked to the water bottom or with anchored floats for aquaculture purposes.

Fish Pen - an artificial enclosure constructed within a body of water for culturing fish and fishery/aquatic resources made up of bamboo poles closely arranged in an enclosure with wooden materials, screen or nylon netting to prevent escape of fish.

Fish Pond - a body of water (artificial or natural) where fish and other aquatic products are cultured, raised or cultivated under controlled conditions. This is a land-based type of aquafarm. Note that the setting-up of fish cages in ponds does not make the operation of fish cage and at the same time a fishpond.

Governance – non market coordination of economic activity.

Industry - the term of industry is used here to describe the group of agents and the full range of activities which are required to bring a product or service from its conception through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumer.

Innovation – change in the though process for doing something, or the useful application of new inventions or discoveries.

Intensive aquaculture – In intensive culture systems there is a decreased dependence on the availability of natural food and greater dependency on the use of commercial feeds. Densities of fish kept within such holding areas are limited by species tolerance, ability to grow at raised stocking densities and maintenance of environmental parameters rather than the production of a natural food supply.

Mangrove - The term mangrove is used to define both a group of plants and also a community or habitat type in the coastal zone. Mangrove plants are trees or shrubs that normally live in the intertidal zone. Mangrove communities are those in which these plants predominate (Spalding, 2004).

Mangroves - a community of intertidal plants including all species of trees, shrubs, vines and herbs found on coasts, swamps, or border of swamps. (RA8550)

Middleman - a person who buys goods from producers and sells them to retailers or consumers.

Municipal fishing - refers to fishing within municipal waters using fishing vessels of three (3) gross tons or less, or fishing not requiring the use of fishing vessels (RA8550).

Municipal waters - includes not only streams, lakes, and tidal waters within the municipality, not being the subject of private ownership and not comprised within the national parks, public forest, timber lands, forest reserves or fishery reserves, but also marine waters included between two lines drawn perpendicularly to the general coastline from points where the boundary lines of the municipality or city touch the sea at low tide and a third line parallel with the general coastline and fifteen kilometers from it. Where two municipalities are so situated on the opposite shores that there is less than fifteen kilometers of marine waters between them, the third line shall be equally distant from opposite shores of the respective municipalities (RA7160).

Polyculture - science of growing two or more compatible aquatic species together in a single pond in the objective of maximising production using organisms with different feeding habits or spatial distribution. It is distinct from integrated system which combine aquaculture with the farming of terrestrial animals and plants.

Resilient - able to withstand or recover quickly from difficult conditions.

Semi-intensive aquaculture – Semi-intensive aquaculture aims to increase the production of fish from pond systems beyond the level supported by food which is naturally available through the use of supplementary feeds. Supplementary feeds range from cereals and agricultural and fishery by-products to formulated feeds. Traditionally they are incomplete and would be inadequate as a sole source of food. Their function is to provide extra nutrients to complement those obtain from natural foods.

System - a set of connected things or parts forming a complex whole.

Value chain – full range of activities that are required to bring a product (or a service) from conception, through the different phases of production, to delivery to final consumers and disposal after use (Kaplinsky, 1999). A value chain exists when all the stake holders in the chain operate in the way to maximize the generation of value along the chain.

ABBREVIATIONS AND ACRONYMS

ACIAR	Australian Center for International Agriculture Research
ADB	Asian Development Bank
ARMM	Autonom Region of Muslim Mindanao
BAS	Bureau of Agricultural Statistics
BFAR	Bureau of Fisheries and Aquatic Resources
BOBP	Bay Of Bengal Programme
BW	Body Weight
c. i. f.	cost, insurance and freight
CIRAD	French Agricultural Research Centre for International Development
CW	Carapace Width
DA	Department of Agriculture
DAR	Department of Agrarian Reform
DENR	Department of Environment and Natural Resources
DOST	Department of Sciences and Technologies
EVAD	Evaluation of Aquaculture System Sustainability
Fao	Fisheries Administrative Order
FAO	Food and Agriculture Organization
FARMC	Fisheries Aquatic Resource Management Council
FASA	Faculté d'Agronomie et des Sciences Agricoles
FLA	Fishpond Lease Agreement
f. o. b.	free on board
FPAVAS	Focused-Food Production Assistance to Vulnerable Sectors
g	Grams
GDP	Gross Domestic Product
GNP	Gross National Product
GVA	Gross Value Added
ha	hectars
LGU	Local Government Unit
m	meter
MAO	Municipal Agriculturist Office
m. t.	metric ton
NAMRIA	National Mapping and Resources Information Authority
NGA	National Government Agencies
NSCB	National Statistics Coordination Board
NGO	Non Governmental Organisation
NFR	NGOs for Fisheries Reform
OPA	Office of the Provincial Agriculturist
PCAMRD	Philippine Council for Aquatic and Marine Resources Research and Development
PIDS	Philippines Institute for Development Studies
PHP	Philippine Pesos
RA	Rapid Appraisal
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SEAFDEC	South East Asian Fisheries Development Center
US$	United States Dollars
WCED	World Commission on Environment and Development

I. INTRODUCTION

I. 1. Selected economic indicators

The Philippines is an archipelago country of nearly 7,100 islands, though it is divided into three general geographical areas : Luzon in the north, Visayas in the center and Mindanao to the south (Appendix 1). It is comprised of a land area of 30.0 million ha (hectars) bordered by 26.6 million ha of coastal waters. Freshwater and brackishwater swamplands, lakes, rivers and reservoirs account for 25.2% of the total land area. As such, it has more water than it has land (Appendix 2).

The population of the country stood at 88.57 million during the last national census in 2007, making the Philippines one the most dense countries in South East Asia and causing demographic pressure on land and other resources. 11.55 million people live in the Manilla region while more than half of the population is located in Luzon. With an average growth rate of 2.05%, the population of the Philippines is expected to reach 100 million in 2012 (NCSB, 2006). 35% of the population is below 15 years old while only 4.2% is older than 65 years old.

In 1980, 51.5% of the labor force worked in agriculture. Only 33.3% worked in the service sector and 15.2% in the industry. Currently, the service sector employs the majority of the labour force (51%). Agriculture and industry respectively account for 35% and 15% of the employment.

The GDP (Gross Domestic Product) of the Philippines is estimated at US$ 143 billion with an estimated growth rate of 7.3%. Agriculture represents 18% of the GDP (Table 1). The industrial and service sector respectively represent 32.5% and 49.2% of the GDP in the Philippines (NSCB, 2007, Appendix 3).

Despite a demographic and economic dynamism, poverty incidence among the population is estimated at 32.9% (Appendix 3). The most affected communities are the fishermen and the farmers with a respective poverty incidence of 49.9% and 44.0%.

Fisheries employ 5% (1.61 million) of the labor force contributing to 2.2% of the GDP. In the agricultural sector, fisheries is more economically important than livestock and poultry. It helps to balance agricultural trade, the Philippines being a major importer of agricultural commodities (Table 1).

Table 1. Selected economic and demographic data in the Philippines. (Exchange rate : US$ 1 = PHP 45 ; 1 € = PHP 60)
Sources : BAS, 2008

Contribution of fisheries to GDP		
	GDP (at current prices)	PHP 6.65 billion
	Share in GDP (at current prices) - Agriculture	16%
	GVA (at current prices) – Crops	50%
	GVA (at current prices) – Livestock & Poultry	21%
	GVA (at current prices) – Fisheries	24%
Export and import of fishery products		
	Value of agricultural exports	US$ 3.17 billion f. o. b (6.3% of total exports)
	Value of agricultural imports	US$ 4.92 billion c.i.f. (8.5% of total exports)
	Balance of trade (deficit)	US$ 1.75 billion
	Value of fisheries exports	US$ 570 million f. o. b
	Volume of fisheries exports	173, 076 m. t.
	Value of fisheries imports	US$ 154 million f. o. b
	Volume of fisheries imports	204,458 m. t.
	Balance of trade (surplus)	US$ 416 million
Employment in the fisheries sector		
	Total population	88.57 million (census 2007)
	Total employment	33.56 million
	Employment in the agriculture sector	11.76 million (35%)
	Employment in the fisheries sector	1.61 million (4,8%)
	Average real agricultural wages	PHP 121.15

I. 2. The fisheries sector

In 2007, the Philippines ranked eighth among the major countries in marine and inland captures in the world. It ranked tenth in aquaculture-based production of fish for human consumption (BFAR, 2007). The volume of fish production (both capture and culture) has been increasing at a level of 5.5 % in the past ten year while its value at 1985 constant prices has been rising since the 1990s (Appendix 4). The sustained increasing importance of the fisheries sector in the Philippines can be linked to the country's archipelagic nature and a demographic fondness for fish (Appendix 2). In 2003, the consumption of fish and fish-products per capita was estimated at 38 kg/year while the world's average was of 16.1 kg/year (BFAR, 2007).

Philippine fisheries production has always been categorized into three modes of production for statistical and administrative purposes : commercial fisheries, municipal fisheries and aquaculture. In 1971, aquaculture produced only 10% of the total output in volume in contrast to 37% produced by the commercial sector and 53% produced by the municipal sector (Primavera, 1995). Of the three modes of production, aquaculture has had the highest annual growth in quantity with 8.7%, followed by municipal fishing with 3.8% and commercial fisheries with 2.8% in the past ten years (Figure 1). In 2008, aquaculture contributed to 48.5% (2.21 millions of m. t.) of the production in volume and 54.5% (PHP 61.5 billions) in value (BAS, 2008).

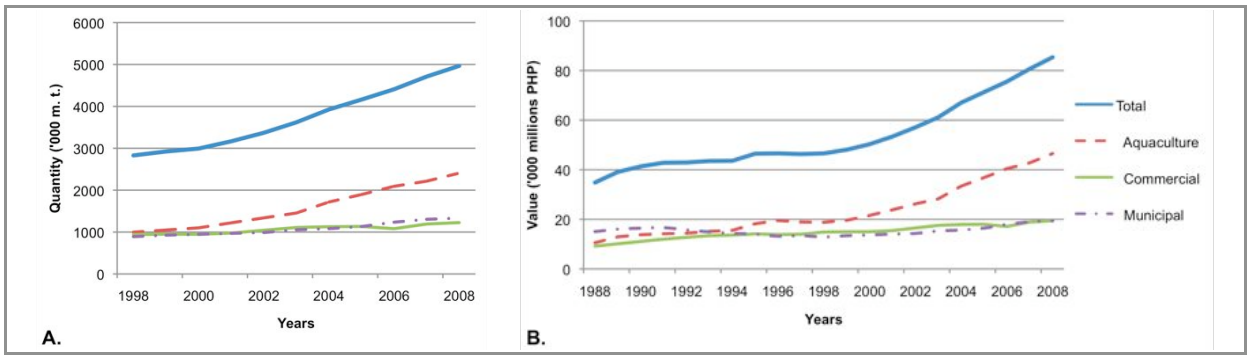

Figure 1. Evolution of fisheries production by sub-sector in volume (A) and value at 1985 constant prices (B). Production has been steadily increasing for ten years. Aquaculture is the fastest growing sector.
Source : BAS, 2007

The dominance of aquaculture by weight is due in large part to the predominance of seaweed production (mainly *Kappaphycus spp.*, *Eucheuma spp.*, *Caulerpa spp.* and *Gracilaria spp.*) in region ARMM (Autonom Region of Muslim Mindanao) and MIMAROPA (IVB). In terms of value, brackishwater environments accounted for two thirds of all aquaculture production (Figure 1). The two major regions of brackishwater production were Central Luzon and Western Visayas. If pens and cage systems have been developed for freshwater environment, only a few are operated in brackishwater (Appendix 4).

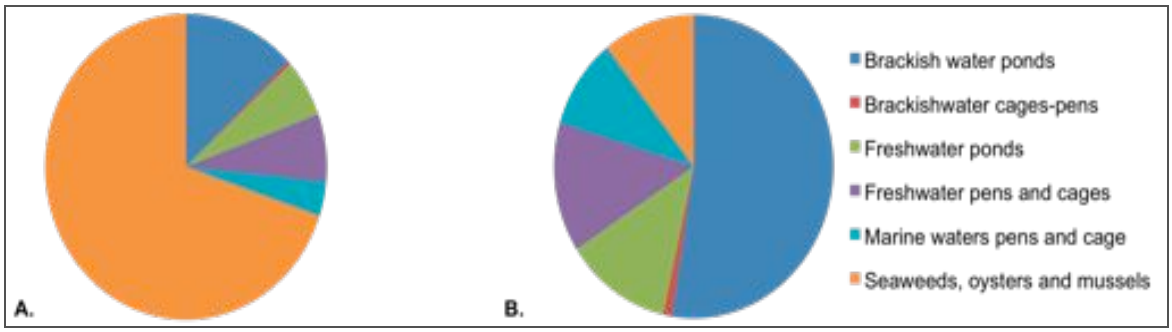

Figure 2. Share of aquaculture production quantity (A) and value (B) by culture environment in the Philippines. Seaweeds are dominant in terms of quantity while brackishwater ponds account for more than half of the production in value. Culture in brackishwater pens and cages is still marginal despite previous implementation attempts since the 1990s.
Source : BAS, 2008

In 2007, the Philippines' export of fisheries product was valued at US$ 570 millons (Table 2). Tuna was the leading export (36% of total value). Shrimps and prawn used to be the number one but have fallen to second place due to production failures. Seaweeds and crabs respectively ranged in third and fourth place (Appendix 4). Major destinations of aquatic products were Japan, the United States of America , Hong Kong, Taiwan and Korea.

Table 2. Major fishery exports in terms of value
Source : BFAR, 2007

Commodity/kind		Quantity (m. t.)	FOB value ('000 US$)
	Agricultural exports	-	3,170,000
	Agricultural imports	-	4,920,000
	Balance of trade	-	- 1,750,000
	Fisheries exports	173,076	570,000
	Fisheries imports	204,458	154,000
	Balance of trade	- 31,382	+ 416,000
1.	*Tuna*	*75,148.345*	*218,628,885*
2.	*Seaweeds*	*26,203.757*	*91,850,596*
3.	*Shrimp/Prawn*	*10,760.235*	*86,500,233*
4.	*Crabs/crabs fat*	*3,990.133*	*40,754,448*
5.	*Octopus*	*6,909.544*	*20,597,210*

I. 3. Brackishwater pond culture production

The earliest production system in brackishwater environment is likely to be the fishponds. They were built on land covered by mangrove ecosystem which was cut and cleared (Yap, 1999). Their existence in the Philippines was first recorded in 1863 (Primavera, 1995) but the practice is considered traditional in the Philippines. The system would rely on the natural water productivity and tidal water exchange. Fry were trapped behind dykes at high tide and remained in the pond when the tide receded. Milkfish was the main species trapped while other species such as penaeid shrimps were used to a lesser degree (Yap, 1999).

The importance of brackishwater pond culture in the Philippines was recognised in the 1940s when it produced 21,440 m.t. (Yap, 1999). In 1951, among 82,230 ha of brackishwater fishponds, 42% were located in Central Luzon and National Capital Region while 34% were found in Western Visayas (Primavera, 1995). The government encouraged the sector in the 1960s and 1970s because it provided livelihood oportunities (milkfish culture) or/and earned foreign exchange (shrimp farming). In a country with an increasing population and with more water than land, mangrove swamps were converted into fishponds and once developped, these lands were titled and transferable (until 1972). The annual rent was low and fishpond land was exempted from the CARP (Comprehensive Agrarian Reform Program) of the DAR (Department of Agrarian Reform). Major consequences were the lack of intensification attributable to the land rent as well as mangrove destruction (Hishamunda, 2009). Between 1950 and 1980, mangrove area was reduced from 418,382 ha to 242,000 ha while brackishwater pond area increased from 72,753 ha to 176,231 ha (Primavera, 2000).

Until the 1980s, the main production system was extensive polyculture with shrimp and prawn production still relying on wild caught fry (Figure 3). The successful development of larval stage in captivity of *Penaeus monodon* in the mid 1970s (Villaluz *& al.*, 1972) led to the development of brackishwater pond production. Between 1980 and 1994, brackishwater pond area increased from 176,231 to 232,065 ha while mangrove area was dropping from 242,000 to 120,000 ha (Primavera, 1995 ; Appendix 4).

Tiger prawn industry really exploded in the 1980s thanks to public sector financing (Primavera, 1995) and market perspectives (Yap, 1999) (Figure 3). In Central Luzon, extensive polyculture was still the main production system. Organic and inorganic fertilisers were applied to boost the natural production of the water, supplemental seeds were stocked in addition to natural stocking and supplemental feeds were added to boost crustaceans' performances. Ponds were still stocked at low densities, the production system being refered to as « extensive plus ». In the Western Visayas and especially Negros Island, tiger prawn production intensified with the use of feed mills ground fishmeal-based diets in a controlled environment (Appendix 5).

After being the world's biggest producer of *Penaeus monodon* in 1984, and after attaining a peak production of 90,426 m.t. a decade later, Philippine shrimp production abruptly dropped in the mid-1990s because of widespread disease and autopollution problems. By 1997, farmed shrimp production was down to 40,080 m.t. (Figure 3). Most severely affected by the disease problems were the high-density shrimp farms in the Western Visayas. Since then, annual shrimp production has remained at a level of 40,000 m.t. with the bulk of the harvest coming from extensive farms (Appendix 5).

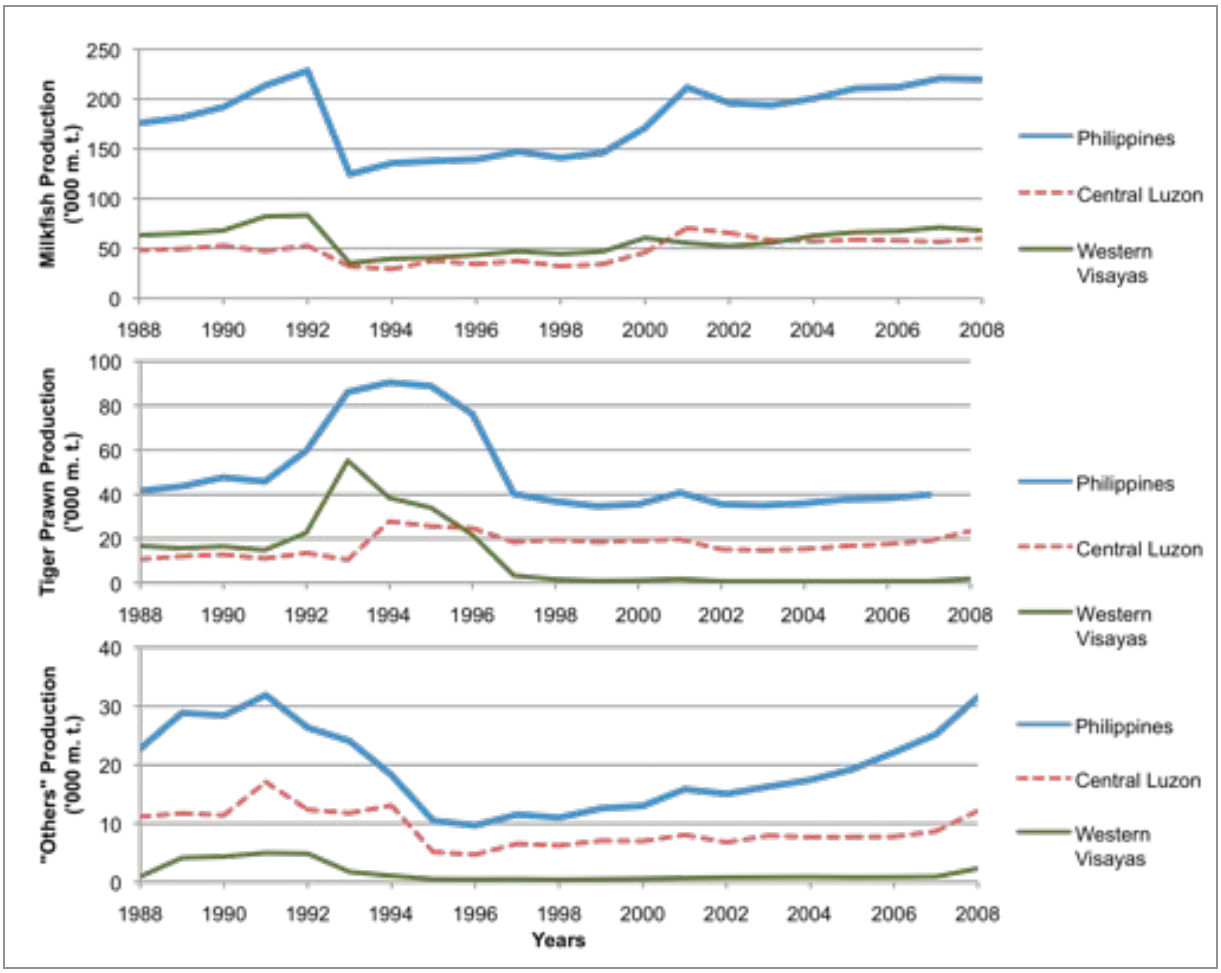

Figure 3. Evolution of the production in brackishwater pond by species for the whole country and for the two main producing regions (Central Luzon and the Western Visayas). Milkfish has always been the primary product but experienced a collapse in the 1990s linked to a shift of some farming systems towards intensive prawn production in the Western Visayas. Tiger prawn decreased in the late 1990s due to disease outbreaks. Since then, the bulk of tiger prawn production has been coming from extensive farms in Central Luzon. Peak in prawn production is also associated with a decrease in the production of « other species » : tilapia, mud crab, white shrimp, endeavour prawn.
Source : BFAR, 1988-2007

Brackishwater pond culture currently represents 285,594 m.t. *i.e* 97% of the brackishwater production and PHP 32.3 billion. Extensive polyculture is the predominant culture system. The main species produced are the milkfish (*Chanos chanos*), the tilapia (*Oreochromis spp.*), the giant tiger prawn (*Penaeus monodon*), the mud crab (*Scylla spP.*) and to a lesser extent the white shrimp (*Penaeus indicus* and *Penaeus merguiensis*), the endeavor prawn or greasyback shrimp (*Metapenaeus ensis)*, the siganid (*Siganus spp.*) and the green grouper (*Epinephelus coioides*). In 2007, *Penaeus vannamei* was introduced as an alternative to the tiger prawn. In 2003, its production was already estimated at 5,000 m. t. (Briggs *& al.*, 2004).

If milkfish is the major commodity in terms of quantity, crustaceans are assumed to be the underlying economic driver (Morissens, 2004 ; Figure 3). Prawns, shrimps and crabs can be sold in the domestic and export market. Wholesale prices recorded for tiger prawn are around PHP 370/kg while crabs and white shrimps are respectively sold PHP 304/kg and PHP 240/kg (BAS, 2008). Milkfish and tilapia are mainly sold in the local market with annual wholesale prices respectively estimated at PHP 75/kg and PHP 56/kg (BAS, 2008).

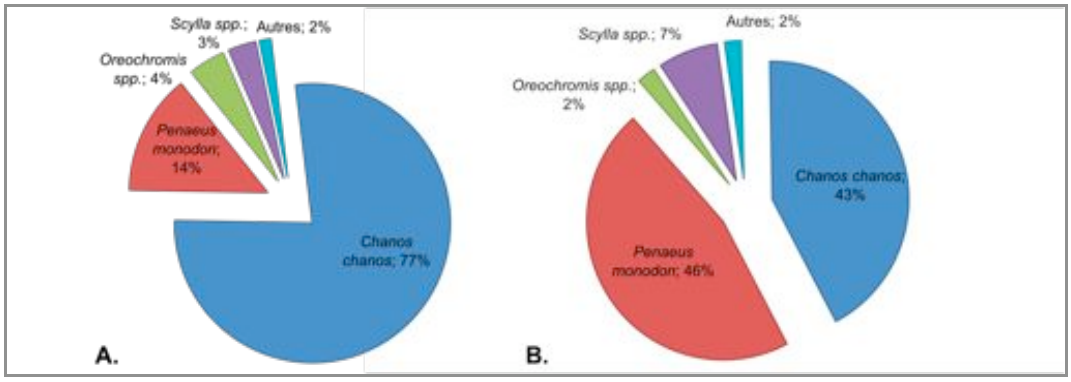

Figure 4. Share of production quantity (A) and value (B) in brackishwater environment by species. Milkfish is the dominant species in terms of production while crustaceans are dominant in terms of value.
Source : BAS, 2008

Culture in brackishwater ponds continues to exhibit a slow but steady growth. Space limitation is a major constraint for the development of brackishwater pond culture since the conversion of mangrove areas was completely banned in the Revised Forestry Code (1991) when its importance in providing goods (from forestry and fisheries) and services (reduction of coastal and riverbank erosions, typhoon and flood control, pollution abatment) was recognised. Indeed, increase in production can not be attributed to an extension of fishpond area and intensive farming as practiced in the 1990s has shown its poor resilience during the prawn crisis. It is believed that increase in production in the last decade has been coming from the success of extensive farming. Major constraints are currently the low survival of the prawns and shrimps presumably linked to pollution problems, poor quality of seed stock and diseases. Considering the low survival of the prawn and shrimps, the production of other species such as tilapia and mud crab are now respectively gaining importance in volume and value.

I. 4. Mud crab production

The culture of mud crab (*Scylla spp.*) dates back to 1890 in Guangdong, China (Shen & Lai, 1994). In the Philippines, commercial exploitation of mud crabs probably began when shrimp culturists started to gather them in order to prevent the destruction of the embankments and predation on shrimps (Angell, 1992). Mud crab culture has been steadily increasing in the past ten years despite a drop in the mid 1990s presumably related to the success of prawn production (Figure 5).

The Philippines is currently the second producer of cultured mud crab with 9,274 m.t. valued at PHP 293,333 (BAS, 2008) mostly coming from brackishwater ponds. China is the first producer with 101,529 m. t. (FAO, 2008) (Appendix 4).

The current wild catch of mud crabs is estimated at 31,835 m. t. with Indonesia cumulating 80% of the catches (FAO, 2008). It should be noted that figures from Sri Lanka and Australia were missing from the FAO database, so that these figures represent an understimate of capture production. The Philippines annualy catch 1,803 m.t. according to the FAO and 719 m. t. according to the BAS. Regarding the statistics of the BAS, the production is also presumably underestimated considering that most fishing is artisanal and landings are not often reported (Appendix 10).

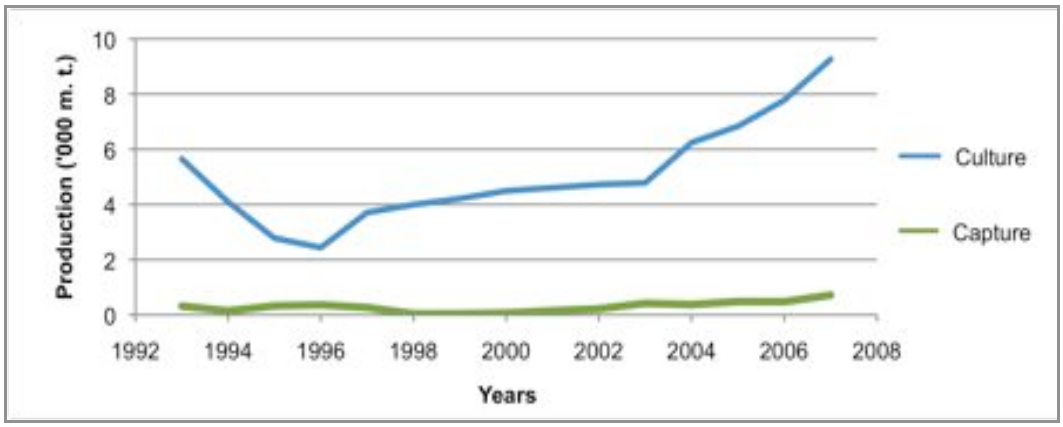

Figure 5. Evolution of mud crab production in the Philippines - Decrease in production in 1993-1994 could be linked to the success of prawn production.
Source : BAS, 2008

I. 5. Rationale and objectives

It is believed that the bulk of mud crab production comes from extensive polyculture in brackishwater ponds (*Hypothesis 1*) where it is a reliable and economically structuring element (*Hypothesis 2*). It is indeed thought that a collapse in mud crab production could be endangering the entire polyculture system as it is practiced today. As shown in Figure 5, mud crab production has been increasing in the past decade. Main constraints to the development of the sector are currently believed to be the supply of crab seeds and the market perspectives. It is believed that mud crab production could keep on increasing and sustaining polyculture production if the sector is sustainably developed (*Hypothesis 3*).

Indeed, through a tentative description of the mud crab sector in three provinces (Camarines Norte, Northern Samar and Pampanga), this study aims at clarifying the current situation to realize the main constraints to its development. More specifically, the following sub-systems were described and analysed :

- the juvenile crab supply chain to the growers ;
- the potential resilience of the different farming systems involving mud crabs and
- the market perspectives of crab culturists in the surveyed areas.

One of the main intentions of this report is to provide guidelines regarding the development of the mud crab industry in Camarines Norte, Minodoro Oriental and Misamis Occidental, three provinces targeted for assistance by the FPAVAS (Focused-Food Production Assistance for Vulnerable Sectors) project. This report also aims to identify relevant research programs to be undertaken for the development of the sector.

II. METHODOLOGY

II. 1. Conceptual considerations

a. Mud crab sector as a dynamic system

The development of mud crab culture is inextricably related to input supply, access to factors of production and access to market. Instead of focusing on a systemic analysis of mud crab production, this study encompasses the whole sector as a dynamic system. It is believed that mud crab culture is not the only motor of the sector and that every sub sector should be given the same attention. In fact, the geographical segmentation of the sector and the diversity of actors are not always compatible with a comprehensive evolution depending on the development capacity of each group of actors.

b. Sustainability : livelihood improvement and conservation

One of the most common definitons of sustainable development emphasizes the economic aspects by defining it as “economic development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs” (WCED, 1987). The field of sustainable development was later on conceptually broken into three constituent parts : environmental, economic and social at the Earth Summit in Rio de Janeiro (1992). The importance of governance was recently underlined (EVAD, 2008).

In this study, the importance of the « economic development » is underlined. It is indeed believed that the main lever to the development of the mud crab sector are the technical feasability of the actions but moreover, their economical rentability. The numerous past examples of the rate and scale at which new technologies may spread once proven effective demonstrates the great capacity of the communities to adapt and adopt a successful business. The main barriers to the development of a sector are considered to be the inequalities in and among the commodity chain but moreover the limitation of ecological carrying capacity which cannot always cope with local dynamism and development. Governance is an obvious constraint to sustainability and this aspect was adressed with caution.

c. Empirical resilience

Another relevant criterion to evaluate the constraints to attain the sustainability of the sector was the resilience of the various activities « a posteriori ». An activity was considered resilient when it had been able to cope with and recover from stress and shocks and maintain or enhance its capabilities, while not undermining the natural resource base.

II. 2. Data collection method

RA (Rapid Appraisal) was formally introduced in the late 1970s. Initially known as RRA (Rapid Rural Appraisal), this methodology was designed as a response to the biased perceptions derived from rural development tourism and the many defects and high costs of large-scale questionnaire surveys (Chambers, 1980). RA emerged to fill in rural development’s need for information that is timely accurate and usable. Considering the limited time frame of the FPAVAS project (January 2010 to October 2011), the quicker the information was collected and analysed, the sooner it could be used.

RA can be described as a way for an outsider to learn, in a limited period, about a community, an activity or an area. RA describes a wide and flexible repertoire of rapid approaches to collecting information in the field. It aims at identifying problems in sufficient details to ensure that subsequent activities are focused on the critical elements of the situation. The surveys are usually carried out very quickly (from a few weeks to a few months) by visiting and talking to informants right on their farms or in their homes.

RA was applied to the mud crab sector from input supply to consumption. The aim was to quickly scope the performance and the sustainability of the whole sector as a dynamic system and to identify the limiting factors in each sub-system and among the sub-system interactions. Indeed, this study encompasses the Rapid Supply Chain Appraisal Methodology of Collins and Dunne (2008) adaptated from Value Chain Analysis (Cuna *& al.*, 2006 ; Duteurtre *& al.*, 2000) and the Rapid Appraisal of Fisheries Management Systems by Pido *& al.* (1997).

II. 3. Data collection tools

The preparatory phase included a review of relevant publications on the mud crab sector and the selection of the surveyed areas. The field work consisted in collecting qualitative and quantitative data through (1) secondary data available locally, (2) direct observations, (3) informal interviews with local experts and key informants and (4) semi structured interviews with the actors of the sector. Preliminary analysis of the collected data allowed to determine the topics that needed specific attention and/or clarification.

a. Review of the existing data

- *Statistical data*

Data regarding the global situation of the economy of the Philippines was gathered from NSCB (National Statistics Coordination Board) while data regarding agriculture was gathered from BAS (Bureau of Agricultural Statistics). The fisheries sector data was mostly obtained from BAS and BFAR (Bureau of Fisheries and Aquatic Resources). Data regarding the physical resources of the provinces was gathered at NAMRIA (National Mapping and Resources Information Authority) for mangrove area and fishpond area.

Statistical data regarding overall mud crab production was available at BAS, BFAR and FAO (Food and Agriculture Organization). If data was relatively easy to access for mud crab culture production, little data regarding mud crab capture was available. Data regarding the collection and marketing of crab seeds at a national level was not be accessed.

Data on mud crab marketing was rather scarce. Prices, supply, demand and supply chain were investigated for milkfish, tilapia and seaweeds by BFAR. Prices were recorded for tiger prawn as well by BAS but no such data was available for mud crabs. The only information available was that of imports, exports, and consumption of crabs in general, classified by export forms. The FAO Globefish report on international seafood trade classifyed crabs upon their preservative form (chilled, live, frozen, processed) as well.

- *Litterature review*

The global understanding of the current situation of brackishwater pond culture was possible thanks to annual reports from the NSCB, the BAS and the BFAR. Published reports made by the BFAR (Lopez, 2006), the Asian Development Bank (ADB) (Walter *& al.*, 2005) and the FAO (Yap, 1999) helped understanding the global framework of aquaculture in the Philippines.

Realizing an exploratory study of the mud crab industry was only possible after a thorough literature review on the sector. The main authors having contributed to the research on the mud crab sector are part of international organizations such as BOBP (Bay of Bengal Programme), SEAFDEC or the ACIAR (Australian Center for International Agriculture Research) or national organisations such as PCAMRD (Philippine Council for Aquatic and Marine Resources Research). National and foreign universities have also contributed to document the sector : University of the Philippines (UP) Visayas, University of Queensland, Rhodes University, University of Stirling, University of Bangor, Wales. It turned out that most publications focused on technical and economical aspects of mud crab culture systems and hatchery production. Few studies dealt with stock assessment while fewer studies dealt with marketing in the Philippines.

- *Collection of secondary data*

To fill in some of the gaps of the national statistics and of the litterature, both published and unpublished material written by staff of the agencies/organizations involved in the mud crab sector were extensively used. Most data has been obtained from Local Governement Units (LGUs) (Abordo & Borero, 2001), Provincial and Regional offices of BFAR (Muhia & Lutao, 2007 ; Buitizon *& al.*, 2003) or Academes (Mindanao State University, 1996 ; Magana, 2001) or NGOs (Non Governmental Organizations) such as the NFR (NGOs for Fisheries Reform). In the studied areas of Pampanga (Central Luzon), several investigations had been undertaken in the past ten years by international research center such as CIRAD or the University of Stirling (Diener, 2000 ; Grandmougin, 2003 ; Stevenson *& al.*, 2004 ; Morissens *& al.*, 2004 ; Irz *& al.*, 2005 ; Baruthio, 2006 ; Hejdova, 2006 ; Chaigne, 2009).

b. Interviews with the participants of the sector

- *Studied areas*

The mud crab industry was investigated in three areas, namely Northern Samar, Camarines Norte and Pampanga (Figure 6). The selection of these sites was based on a combination of opportunistic and objective criteria.

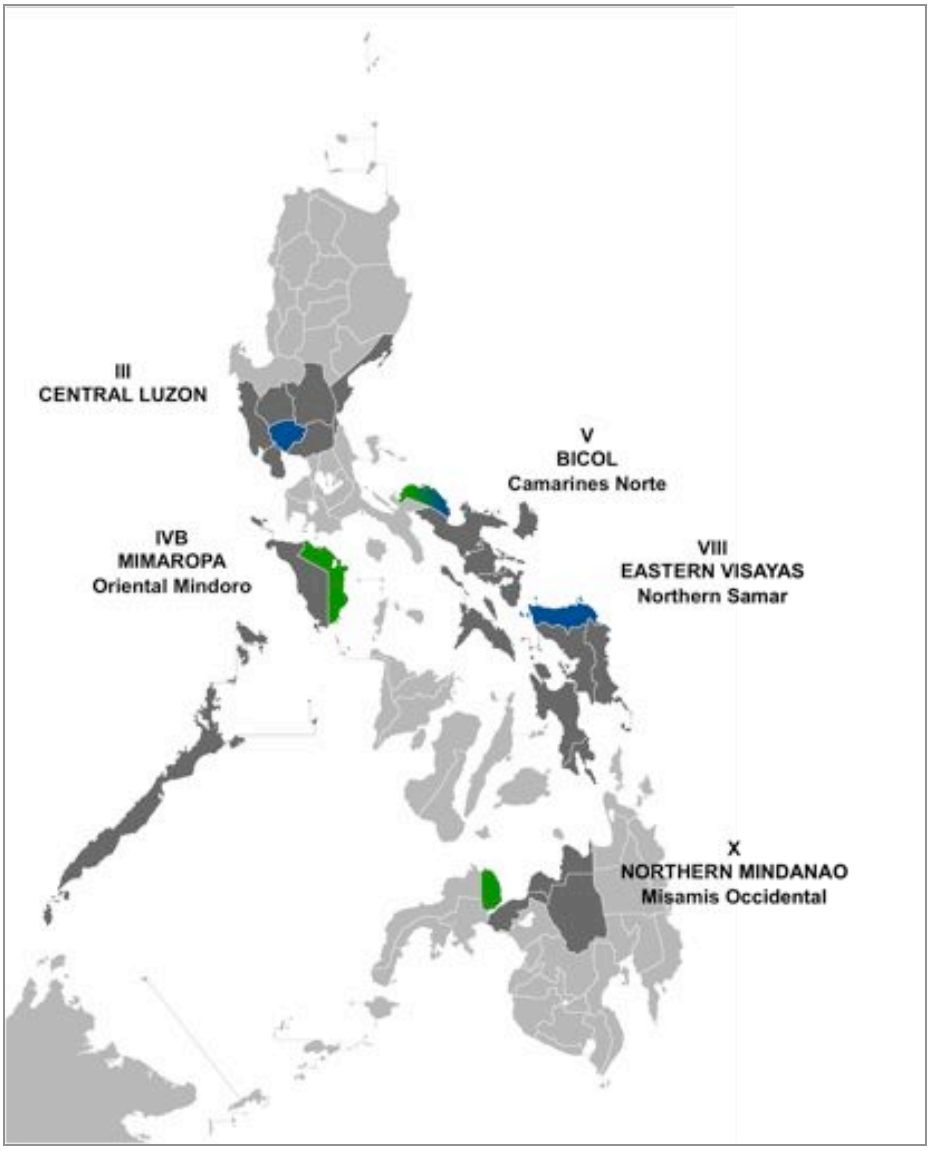

Figure 6. Map of the Philippines. The surveyed provinces are highlighted in blue. The province dealing with mud crab farming/fishing are and targeted by the SEARCA-FPAVAS project are highlighted in green.

Northern Samar is located on the eastern edge of the Philippines, bounded on the north by the San Bernardino Strait separating Luzon from Samar. This province has been identified as a major source of crab seeds. With an estimated 10,720 ha of mangroves, brackishwater resources are assumed to be abundant (NAMRIA, 2003). A controversial ban on the export of juveniles outside the province has been recently implemented for the conservation of the wild stock of crabs. With 270 ha of ponds, mud crab culture production represents a mere 1% of the national production. Northern Samar being one of the poorest provinces in the country (NCSB, 2007 ; Appendix 6), NGOs and NGAs (National Government Agencies) have attempted mud crab culture development projects in the province and experienced failures. One should investigate appropriate regulations regarding conservation of mud crab stock, as well as issues regarding the development of mud crab culture.

Camarines Norte is located in the northern coast of the Bicol Peninsula of Luzon Island. It is bounded on the North by the Pacific Ocean, in the East by San Miguel Bay and in the west by Lamon Bay. Camarines Norte has also been recorded as a major source of crab seeds (Fortes, 1997). Crab seeds are mostly exported to the culturing provinces of the North of Manila Bay. Despite a relatively large area of brackishwater ponds and the availability of seeds, mud crab production is still marginal with 123 m. t. produced in 2007 as shown in Table 3 (BAS, 2008). As such, a PO (People's Organisation) of crab producers in Daët has been targeted by the FPAVAS project for assistance to the development of mud crab culture with the general objective of « helping to reduce poverty, improving the well being of the farmers and ensuring their access to safer food, particularly the vulnerable sectors ». Considering the proximity of the province to the capital and the local availability of wild crabs, the potential for the development of mud crab culture was investigated.

Pampanga is located in Central Luzon on the northern shore of Manila bay. The province is the number one producer in brackishwater ponds in volume and value. The region significantly contributed to the supply of milkfish, tilapia, crustaceans and other cultured commodities in the National Capital Region (Appendix 6). Mangrove area has been cleared for ponds construction and is now limited to river beds. As a paradox, the productivity and the sustainability of brackishwater ponds culture is often directly dependent on the continuous support of mangrove goods such as fry and broodstock as well as services including water quality maintenance and erosion control. As a consequence of mangrove destruction, fishpond operators in Pampanga rely on other provinces with larger mangrove area such as Camarines Norte and Northern Samar for the seed supply. Another issue is the low survival of tiger prawn presumably related to auto-pollution problems. Considering the importance of Pampanga in the supply of fish and crustaceans, the sustainability of the production should be assessed. Assuming the economic importance of mud crab production in polyculture, the sustainability of the sector was evaluated.

Table 3. Selected statistics of the studied areas
Source : NAMRIA, 2003 ; BAS, 2007

Province	Mangrove area	Fishpond area (fresh and brackishwater)	Brackishwater pond production	Mud crab production
Camarines Norte	5,460 ha	3,360 ha	448.02 m. t.	123.00 m. t. (27% of BW pond production)
Northern Samar	10,720 ha	270 ha	434.91 m. t.	94.18 m. t. (22%)
Pampanga	-	15,120 ha	40,488.74 m. t.	3,210.47 m. t. (8%)

Manilla is an important center for mud crab consumption and export. The exporters in Paranaque as well as retailers were met.

- *Sampling respondents*

Prior to interviews with the participants of the mud crab sector, institutional actors (LGUs, BFAR, NGOs) were met within the localities. The staff was usually able to provide a list of key informants, *i.e.*, members of the communities who were especially knowledgeable about the mud crab sector.

To ensure a variety of perspectives, the diversity among the key players of the representatives of the different sub sectors was deliberate. It was sometimes difficult to get a representative sample of the existing diversity from the institutional actors but the first interviews would allow to precise sampling.

Interviews were conducted between April and July 2010. The number of interviews ranged between nineteen and thirty three per province depending on the availability of the operators with a total of eighty two persons. Sixteen key players in the crab seed supply chain were interviewed. The crab seed catchers were not specifically met considering the availability of secondary data and the involvement of some fishpond operators and crab seed traders in the activity. Twenty six interviews were conducted with mud crab producers and mostly focused on mud crab culture considering the importance of the sector for the study. Seveteen persons involved in the marketing channels of mud crab were met. Information regarding the marketing strategies was not always easy to obtain from this key players because of confidentiality issues.

Table 4. Number of interviews per province and per link. Interviews were conducted during 4 month, from April 2010 to July 2010. In each province, 20 to 30 key informants in the mud crab sector were interviewed.
Source : [1]Abordo & Borero, 2001 ; [2]Muhia & Lutao, 2007 ; [3]Buitizon & al., 2003 ; [4]survey data

Studied province / Link	Camarines Norte (23/03/2010 to 30/04/2010)		Northern Samar (24/05/2010 to 07/06/2010)		Pampanga (21/06/2010 to 30/07/2010)		*Total*	
	Participants	Sample	Participants	Sample	Participants	Sample		
Seed stock catchers	-	- (150[1])	1,226[2]	2 (228[2])			2	
Crab seed traders	20[4]	9	15[2]	4	-	3	16	**18**
Hatchery operators	-	1 (BFAR)	-	-			-	
Nursery operators	-	-	-	1 (NGO)			-	
Culure operations	165[3]	10	21[2]	7	3,013	7	24	**24**
Middle men	-	1	-	2			3	
Buying station operators	-	4	-	2	-	2	8	
Wholesalers					-	4	4	**17**
Retailers	-	2	-	-	-	-	2	
Exporters	*located in Manila, Parañaque city*						-	
LGUs	-	4	-	6	-	2	12	
National Agencies	-	2	-	2	-	1	5	
NGOs	-	-	-	3	-	-	3	**23**
Academes	-	2	-	1	-	-	3	
Total	**-**	**33**	**-**	**30**	**-**	**19**	**82**	

- *Semi-structured interviews with key informants*

Semi-structured interviews were conducted in conversational mode with key informants in order to collect qualitative and indicative (quantitative) data in the three surveyed provinces. Semi-structured interviews allowed maneuverability in exploring emergent themes. The game of questions and answers is hazardous in this context since the respondent can prepare their answers depending on the interviewer's expectations. Interviews were always conducted with a third person allowing the respondent to answer in their own language. This is particularly important in the Philippines, where some respondents can be « ashamed » to talk directly to a foreigner and moreover in English.

A similar questionnaire was designed for capture operators, culture operators and traders after the methodology of commodity chain analysis. The main sections of the questionnaire were « Profile of the respondent » ; « Technical and economical description of the activity » ; « Marketing (prices, quantities) » ; « External influences » (Appendix 7). The flows of products, payments and information were evaluated alongside the organization of the sector. For the fishpond operators, sections regarding their « Access to factors of production » and a « Technical description of the farming systems » were added after the survey of Grandmoungin (2003), Diener (2000) and Irz (2005).

The main topics that were discussed with institutional actors were identified after a litterature review on the mud crab sector and a global understanding of the institutional framework in the Philippines. The main sections regarded « Access to land » ; « Technical advice » ; « Financial support » ; « Access to market » ; « Organization of people » ; « Environmental protection » (Appendix 7).

II. 4. Data analysis

a. Delineation of the mud crab sector

The mud crab sector involves a wide range of activities and group of actors. Prior to its description, the sector was clearly delineated. The first step was the identification of the core processes necessary to bring mud crab seed stock to marketable size and quality. Three main core processes were identified breaking the mud crab sector into three sub-systems : procurement of seed stocks, transformation in culture operations and finally delivery to consumers.

b. Suggesting a comprehensive description of the sector

Interviews of the key players of the mud crab sector were retranscripted in a simple table displaying the topics mentioned in the questionnaires to allow an individual understanding of the farming and trading systems and to standardize the collected data (Appendix 7). The interviews were then retranscripted into table form to allow comparison between actors.

Each sub-system was investigated to provide a quantitative and qualitative mapping of the industry. The qualitative part involved identifying the players and their roles, the linkages among players, the activities along the chain as well as the logistics and policy issues. The quantitative part encompassed the technical description of the activities as well as the distribution of costs and earnings along the chain.

c. Mapping the mud crab sector

The collected information were synthesized in various maps to provide a global understanding the mud crab sub-systems. The objective was to visualize networks in order to get a better understanding of the connections and to demonstrate the interdependency between actors and processes in the commodity chain. Typically, the key players and their linkages ; the technology and the economics of the activities were mapped. The volumes of products and/or the number of actors were mapped when the information was available

d. Identifying key issues

Constraints to the sustainable development of the mud crab industry were determined from the jumble of information collected. The major issues identified by the stakeholders and the experts of the mud crab sector were discussed thanks to the data collected during fieldwork and to the scientific data available.

The final objective was to suggest research actions that could be taken to contribute to the development of the sector. Major long-range concerns about the sustainability of aquaculture such as poverty alleviation are mentioned but these topics are not discussed further.

II. 5. Limitations

a. Limited scope of the study

The main difficulty in this study was its wide target : a whole sector investigated, a wide variety of group of actors in each subsector and a wide geographical distribution of the subsectors. This study required to look at the industry from a distance in order to discern its main characteristics and identify the main constraints.

However, this study can not be generalized to the whole country nor to the whole sector. The study focused on three provinces in which issues on mud crab culture and aquaculture in general were significantly different. The data regarding brackishwater pond culture was mostly gathered from operators in Pampanga because it was relatively easy to access. The situation in Pampanga is however not representative of brackishwater pond culture in the country because of environmental specificity and geographical location. Hence, differences were observed between the collected data and national statistics. Other major brackishwater culturing regions such as the Western Visayas, Ilocos Region and Northern Mindanao should have been visited to provide a more complete and fair understanding of the sector.

b. A teamwork

A major difficulty of this study was communication. Most operators did not speak fluent English which necessitated the help of a translator. Some information and precision, was probably lost in translation. As much as possible, the foreign investigator should work along with a local investigator to circumvent or ameliorate these issues.

Rapid Appraisal usually requires a multi discipinary team. Considering the objective of the study, the team should have included a fisheries specialist, an economist and probably a sociologist to give a decently full and fair understanding of the sector. As an agronomist, my vision of the market situation was fairly simplistic. The World Fish Center provided assistance to enrich the study, but conducting the study with an economist would have been optimal.

c. A participatory approach

The participatory approach allows people from the community to discuss the issues that they feel are important. Indeed, the interviews were conducted in a way that the respondent could explore new topics. However, the final suggestions regarding the development of the mud crab sector should have been discussed with the communities and the institutional actors. Focus group discussions would have given insights concerning the necessary conditions for changes to happen.

III. RESULTS

III. 1. Delineation of the mud crab sector

The purpose of the whole mud crab sector is to transform juveniles or low valued adults into marketable crabs for consumption in the domestic and export market. The first process of the mud crab sector is the wild catch of seed stock in the mangrove. In grow-out operations, mud crab are caught at an early stage and raised until they reach the marketable size. In fattening operations, low valued sub-adults or adults are cultured for a short period until they flesh out. Low valued crabs refers to watery crabs (post-molt) since fat crabs fetch highest price by far. The « fat » is considered as a delicacy in the Asian market. Wild-caught mud crabs can also be directly sold without being transformed through any culture operations. Depending on the quality and the sizes reached during the transformation process, mud crabs are marketed through different channels before reaching the local or foreign consumer.

The mud crab sector can be divided into three sub-systems : procurement of mud crabs from the wild, transformation in culture operations and delivery to the consumers (Figure 7). Considering that the study focused on grow-out in brackishwater pond culture, a particular attention was given to the supply of juveniles and to the grow-out operations. Information regarding the catch of adults and fattening practices were gathered to a lesser extent.

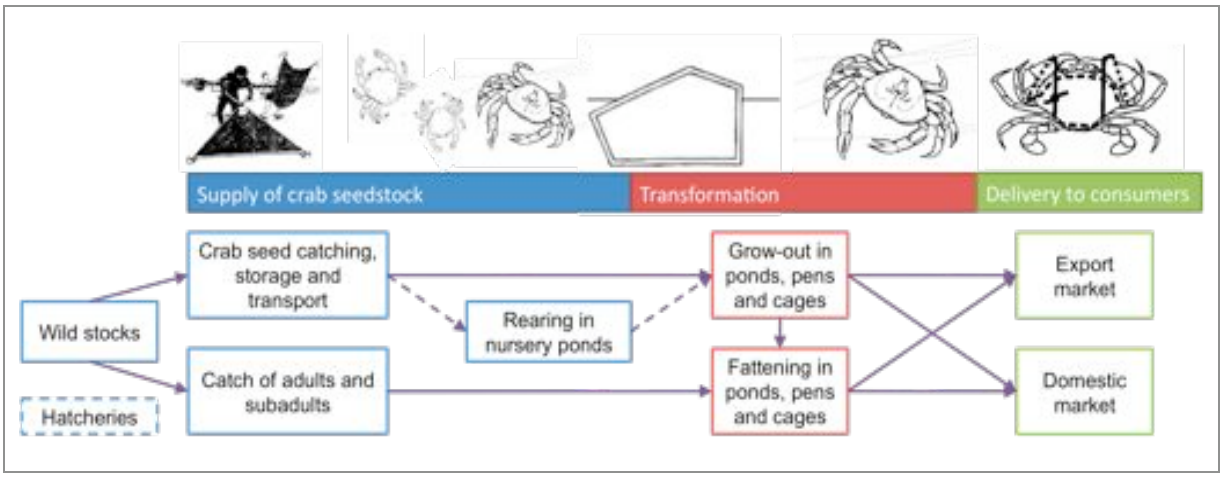

Figure 7. Identification of the core processes involved in the mud crab sector : from catching the seeds in the mangrove to selling to consumers in the retail market or to export.

III. 2. The mud crabs

- *Taxonomy*

Scylla spp. is a genus of swimming crab of the Portunidae family. The taxonomy of *Scylla spp.* is still uncertain dating back to the description by Estampador (1949) in the Philippines of three species and one variety. This taxonomy was later revised by Stephenson & Campbell (1960), who recognized only one species of *Scylla*, namely *Scylla serrata*, and by Keenan *& al.* (1998), Keenan (1999) who divided the genus into four separate species based molecular biology. The four species, *S. serrata*, *Scylla tranquebarica*, *Scylla olivacea* and *Scylla paramamosain*, could be distinguished by external characters (Figure 8).

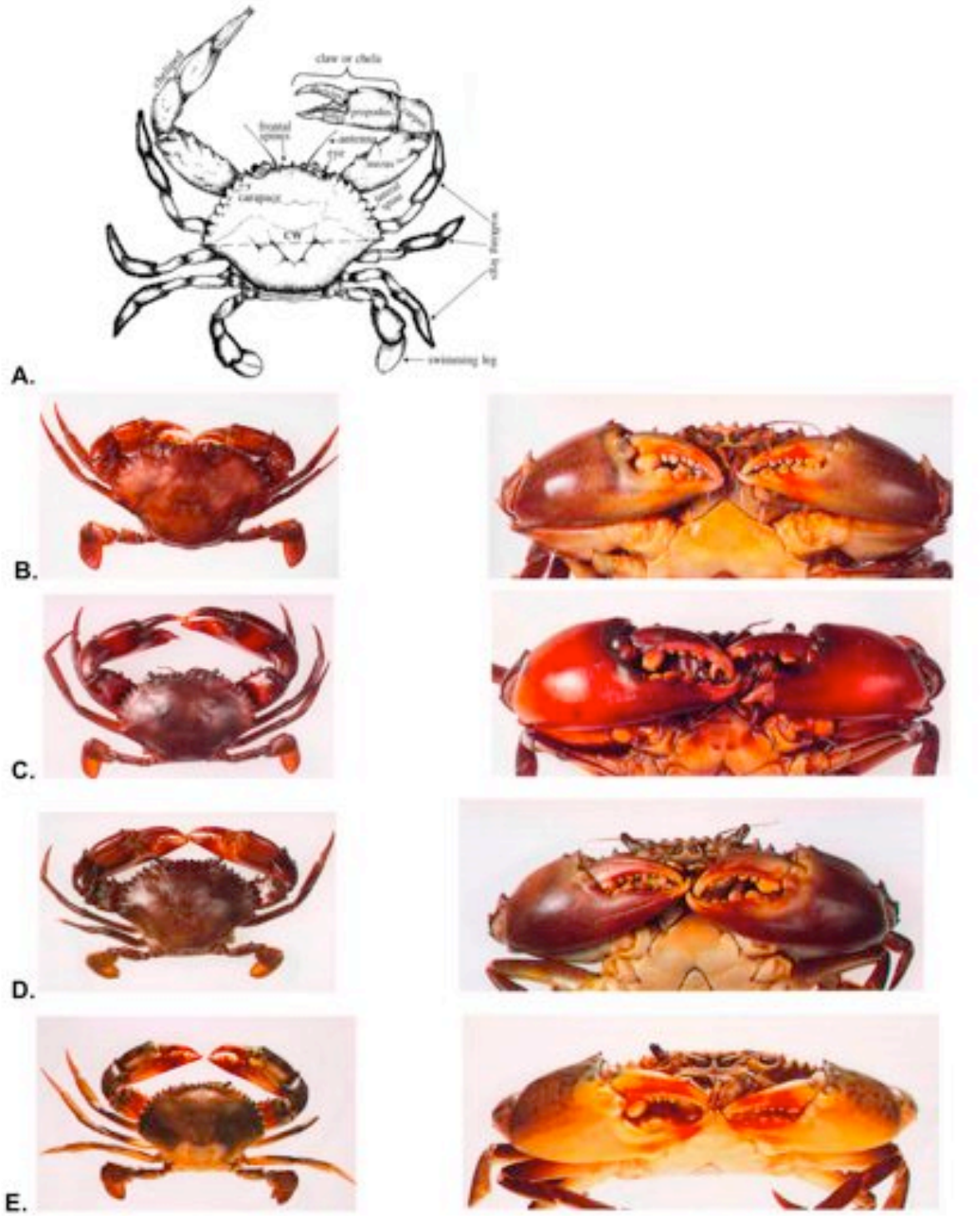

Figure 8. Recognising the different species of mud crab present in the Philippines

(A) Anatomy of Scylla spp.

(B) Photograph of female Scylla serrata *showing diagnostics features : high buntly pointed frontal lobe spines ; pairs of large spines obvious on carpus and propodus ;* ***polygonal patterning clearly present on all appendages****. dorsal, frontal. Photo : Queensland Museum*

(C) Photographs of adult male Scylla olivacea *showing diagnostic features : low and rounded frontal lobe spines ; pair of reduced spines obvious on propodus, on carpus inner spine absent and outer spine reduced ;* ***polygonal patterning absent from all appendages****. dorsal, frontal. Photo : Queensland Museum*

(D) Photograph of adult male Scylla tranquebarica *showing diagnostic features : moderate, blunted frontal lobe spines ; pairs of large spines obvious on carpus and propodus ;* ***polygonal patterning present on the last two pairs of legs, weak or absent on other appendages****. dorsal, frontal. Photo : Queensland Museum*

(E) Photograph of adult male Scylla paramamosain *showing diagnostic features : moderatly high, pointed and triangular frontal lobe spines usual ;pair of large spines obvious on propodus, on carpus inner spine absent and outer spines reduced ;* ***polygonal patterning present on last two pairs of legs****, weak or absent on other appendages. Photo : Queensland Museum.*

Source : SEAFDEC, 2010 ; Keenan, 1999.

- *Geographical distribution*

Representatives of the genus *Scylla* are found across the Indo-West Pacific. *Scylla serrata* has the widest distribution (South Africa, Red Sea, Australia, Philippines, Taiwan) and is the only species so far recorded in the Western Indian Ocean, Japan and the South Pacific islands. *Scylla tranquebarica* and *Scylla olivacea* have distributions focused on the South China Sea, extending into the Indian Ocean and the western Pacific, while *Scylla paramamosain* appears to have a more limited distribution, being mostly restricted to the South China and Java Seas (Le Vay, 2001). In the Philippines, the mud crab species cultured are *S. serrata*, *S. tranquebarica* and *S. olivacea*. *S. serrata* is usually referred as « King Crab » or « White Crab » (« Puti » or « Bulik » in local languages) and is often confused with *S. tranquebarica*. *S. olivacea* is known as « Native Crab » or « Red Crab » (« Pula » or « Pulahan » in local languages).

- *Environment*

Apart from spawning migrations where females may travel considerable distances offshore, mud crabs are mostly found in estuarine and sheltered coastal habitats. Large populations are generally associated with established mangroves. Mud crab can tolerate a temperature of 16°C - 27°C (Heasman, 1980) or 3-45°C (Islam & Bhuiyan, 1981) and a salinity ranging between 1 and 42 ‰ (Davenport & Wong, 1987). Hill (1974) established that the early larval stages of mud crab show considerable mortality at salinity below 17.5 ‰ and tolerate a temperature between 10 and 25°C.

The conditions determining local distribution and abundance of the four mud crab species are likely to be complex (Le Vay, 2001). In North Australia, the habitat of *Scylla olivacea* has been described as limited to mangroves and coastlines with reduced salinity (<33‰) especially during the rainy season. A similar habitat was described for *Scylla tranquebarica* but with slightly more elevated salinity requirements. Although associated with mangrove, *S.tranquebarica* may also inhabitat coral reef rubble, shallow subtidal flats and estuarine ponds. *Scylla serrata* can tolerate reduced salinity but is commonly associated with mangrove forests inundated for most of the year with full salinity oceanic water. It is dominant in oceans where salinity is higher than 34‰ (Keenan & al., 1998).

The local distribution of *Scylla serrata* populations in South Africa (estuaries) and Australia (tidal flat) has been studied by Hill (1975; 1978) and Hill *& al.* (1982) by mark-recapture. They found that distribution and abundance depend on the developmental stage; juveniles up to 8 cm carapace width were most abundant on intertidal flats, while subadult and adult crabs were more subtidal in habit. In Thailand where the range of *Scylla paramamosain* and *S. serrata* overlaps, there also appears to be some niche separation with *Scylla olivacea* reported to live within the mangrove root system while *S. paramamosain* lives sub-tidally (Overton & Macintosh, 2002).

- *Feeds and growth*

Early stages feed on zooplankton. *Scylla serrata* juveniles are omnivores that feed primarily on crustaceans. Adults are primarily carnivorous, the dexterity of their mouthparts enables them to feed on a variety of large, hard-shelled mollusks and crustaceans (Heasman *&* Fielder, 1978 ; Williams, 1978). Mud crabs are also opportunistic scavengers and eat a wide variety of animal protein and even vegetable matter such as filamentous algae (Williams *&* Primavera, 2001) and cooked maize (Rodríguez *& al.*, 2003). Mud crabs are mostly nocturnal or crepuscular, hiding during the day in burrows and foraging on mud flats from late afternoon to early morning, particularly during flood tides (Barnes *& al.* 2002).

Among the four *Scylla* species, *Scylla serrata* has the highest growth rates, attaining maximum male sizes of 250 to 280 mm CW (Carapace Width) and 2 to 3 kg BW (Body Weight). *Scylla paramamosain* and *Scylla tranquebarica* attain 200 mm CW and 180 mm CW for *Scylla olivacea* (Carpenter & Niem 1998).

- *Reproduction*

The most common criteria for sexual maturity in *Scylla serrata* are the presence of mature abdomen form and mature ovaries for females, and the presence of sperm in sperm ducts and mating scars for males (Robertson & Kruger 1994). In general, there is a trend towards smaller sizes at maturity in the lower latitudes. Larger size-at-maturity are reported in *S. serrata* of the east coasts of Australia and South Africa with female first reaching maturity at about 120 mm carapace width (Appendix 7).

Maturation and spawning is continuous throughout the year with seasonal peaks variable depending on the location (Le Vay, 2001). Both Heasman *& al.* (1985) and Quinn & Kojis (1987) reviewed published material on the periodicity of spawning and suggested that spawning peaks become more pronounced and less protracted with decreasing latitude. In tropical populations, a higher incidence of maturation in females appears to be associated with seasonal high rainfall, that may be related to periods of high productivity in coastal waters (Heasman *& al.,* 1985). In sub-tropical climates, seasonality in reproduction is more strongly related to temperature and day-length, with a distinct peak spawning season in the summer when water temperatures are highest (Le Vay, 2001). In the Philippines, *Scylla spp.* mature all year round with a peak in May-October (Arriola, 1940 ; Estampador, 1949).

A universal phenomenon in *Scylla* populations appears to be offshore migration of females to spawn. A female mud crab can release 0.5 to 4 million eggs in one spawning (Chen 1990 ; Latiff & Munsa, 1995). The presence of a high proportion of females with spent ovaries in coastal populations of *Scylla serrata* indicates that many are able to return to the coast after spawning (Heasman *& al.*, 1985). Migration may be more a dispersal mechanism than a requirement to ensure optimal conditions for larval survival (Hill, 1994).

After hatching, mud crabs commonly display 6 larval stages (L1-L6); 5 pelagic zoeal stages (Z1 – Z5), followed by one megalopa larval stage (M). Larval stages last three or four weeks (Ong, 1964). After this period, the semi-benthic megalopa returns to the shallow coastal environment and settles into sheltered, shallow water habitats (mangrove root pneumatophores, sea grass beds) where they metamorphose into juveniles or crablets (Hill *& al.,* 1982) (Appendix 7).

Few detailed studies of juvenile recruitment have been undertaken. In subtropical climates, juvenile recruitment follows the seasonal patterns for reproduction, being closely related to water temperature. In tropical populations, juvenile abundance may be related to seasonal variation in rainfall and salinity (Angell, 1992). However, despite seasonal peaks, recruitment can be continuous throughout the year in both sub-tropical and tropical populations (Chandrasekan & Natajaran, 1994; Forbes & Hay, 1988; Robertson, 1987; Robertson & Kruger, 1994). Lebata (2007) reports a year round recruitment for *Scylla olivacea* with a higher rate of smaller immature crabs during the summer months.

Juveniles migrate from inter-tidal to sub-tidal habitats (Le Vay, 2001). Mud crabs typically undergo 14–16 moults prior to reaching their maximum size (Shelley, 2004). Schematically, the crab is fat near the end of its intermolt cycle and becomes watery after molting because of the seawater absorbed. Moreover, the newly molted crab is vulnerable to cannibalism ; hence, it seeks shelter or burrows to escape predation. *Scylla* species bury in soft mud or construct burrows in firm mud (Macnae, 1968 ; Hill, 1978), hence the common name ‘mud crab’. Since burrows may weaken or destroy the dikes of culture ponds, fences are installed to prevent crab burrowing and escape.

III. 3. The seedstock suppliers

a. Relative abundance of mud crab seedstock

- *Species and sizes*

Scylla serrata is the favoured species of crab culturists considering its higher growth rate. *S. serrata* and *Scylla tranquebarica* are not always differentiated and grouped under the name « White crabs » as mentionned earlier. White crabs are caught from early stages (2mm or « fly size ») up to adult sizes (Figure 9). The caught of early stages for stocking in ponds presumably started five years ago considering that bigger sizes were getting scarce.

Scylla olivacea is appreciated for its tolerance to lower salinity especially in rainy season but can never reach the same size and price of *Scylla serrata*. *S. olivacea* or « Red crab » has however the reputation of being agressive and of destroying the embankments. Red crabs are caught starting from 30 mm up to adult size. Considering that this species is less demanded, bigger sizes are relatively easy to access.

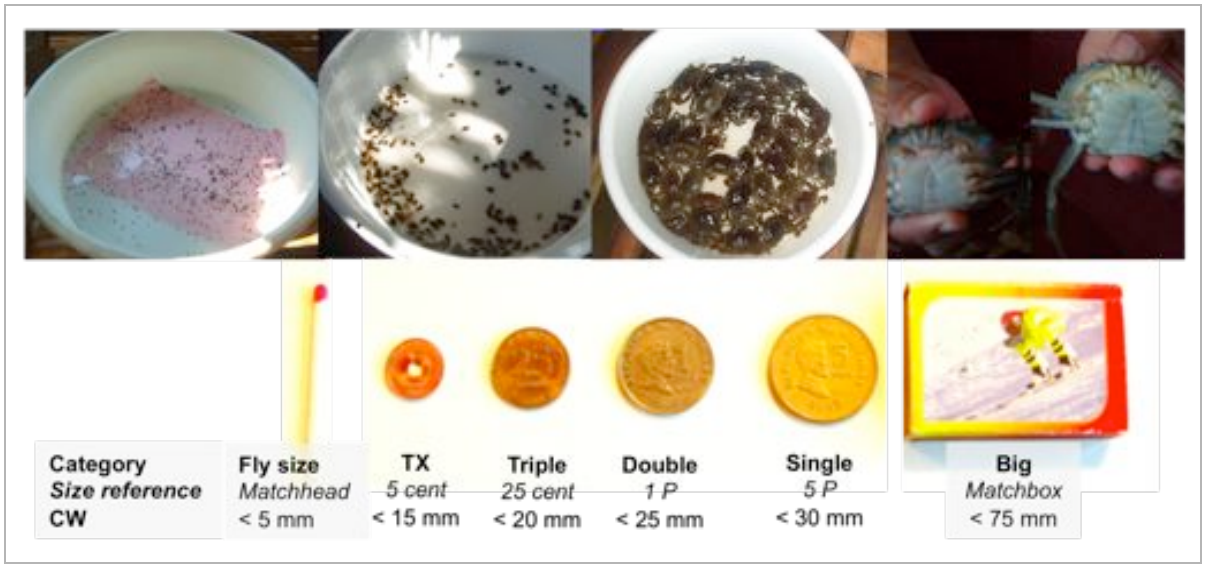

Figure 9. Crab seedstock : category of sizes and species. From left to right : fly size ; triple ; big ; red and white crabs can be distinguished for the biggest sizes.

- *Geographical distribution*

Scylla serrata naturally occurs in Cagayan (Region of Cagayan Valley) ; Sorsogon and Camarines Norte (Bicol Region) ; Samar (Region of the Eastern Visayas). It is indeed believed that *S. serrata* can be found in locations facing the Pacific Ocean.

Scylla olivacea seems to be sourced from Capiz (Western Visayas). However, *S. olivacea* naturally occurs in Cagayan Valley and Bicol Region as well depending on the season.

Other recorded provinces for the supply of crab seed stocks are Masbate and Camarines Sur (Bicol Region) ; Barotac Nuevo, Dumangas, New Washington, Aklan, Negros Occidental (Western Visayas); Bataan (Central Luzon) ; Lanao and Misamis (Northern Mindanao) and Zamboanga with no specification on species (PCAMRD, 1996). Other provinces such as Palawan (MIMAROPA) or Sulu (Region ARMM) are potential sources of wild crabs considering the extent of mangrove areas but no data is available regarding the relative abundance of the different species (Appendix 2).

- *Seasonnal pattern*

The availability of early stages is seasonnal, presumably following the pattern of spawning and recruitment season. In the Philippines, mud crabs are believed to mature all year round with a peak in May-October but the species is not specified then (Arriola, 1940 ; Estampador, 1949). According to the traders, the peak season for early crab stages of white crabs were January to March in Northern Samar and Camarines Norte, April to June in Cagayan. The peak season for early stages of red crabs would be from July to October in Camarines Norte. Larger sizes were found all year round but obviously in a lesser quantity than the early crab stages in recruitment season.

The availability of the two group of species (red and white) was also seasonnal, probably related to rainfall and salinity (Angell, 1992). In Camarines Norte, white crabs were caught from January to September while red crabs were caught from October to December. This is consistent with the species tolerance to salinity. In Northern Samar, white crabs would be available all year round.

b. Key players, their role and links

The supply chain of seedstock starts with their capture in the mangrove. Mud crabs are then sold to aquaculturists in the locality or transported to culturing areas by traders. Watery crabs are usually caught by fishermen and sold to a nearby buying station. Farmers engaged in fattening can be supplied by this stations but are more likely to catch or grow the crabs themselves (Figure 10). The supply of thin crabs is not specified in this paragraph considering that post molt crabs undergo the same channels as marketable crabs.

- *Crab hatchery and nursery operators*

Work on crab larval rearing started as early as the mid 1970s in the Philippines but past attemps were rather sporadic. Viable hatchery technology is now available for *Scylla paramamosain* in Viet Nam and for *Scylla serrata* in the Philippines, Indonesia and Thailand. Nursery technologies have been developped by research organisms (Rodriguez *& al.*, 2007).

According to SEAFDEC (2010), three hatcheries are operating in the Philippines : *WESAMAR multi-species hatcheries*, located in Western Samar, *Initiao hatchery* located in Misamis Occidental and one located in Capiz. In Camarines Norte, a BFAR prawn hatchery had been producing mud crabs juveniles and was expecting to run another trial. It seems that mud crab hatchery technology has not been adopted by the private sector yet.

Nurseries have been locally developped by NGOs and LGUs in Northern Samar. In Camarines Norte, nurseries were spontaneously developped by crab seed traders, not so much to increase their profit but to limit losses linked to mortality.

- *Seed stock catchers*

In the 1990s, the number of mud crab fishermen in the Philippines was estimated at 50,000 (Angell, 1992). In Northern Samar, Muhia & Luta (2007) estimated that 1,226 persons were involved in catching crab seeds.

In Camarines Norte, age composition of the seed catchers ranged between 11 and 74 years old. 71% of the respondent were elementary graduated, 28% were high school graduate and 1% were college graduated. The shortest experience of the catchers was 1 year and the longest was 21 years. Among the 150 respondents, 143 were men, only 7 were women. Seed catchers were engaged in other fishing and farming activities in relation to the seasonnality of the availability of crab seeds (Abordo & Borero, 2001). The reasons for engaging in collecting crab seeds could be the access to cash immediatly after harvest or that the profit was good considering the low capital engaged. Aquaculturists could also be engaged in the collection of seeds to ensure their supply and minimize their operational costs.

Catchers would sell the majority of their harvest to traders or directly to fishpond operators in the locality. Traders in direct relation with catchers would develop a relationship of trust and loyalty with them to ensure their supply. Common practices of the traders were to lend fishing gear for free or to simply ask the catchers to go fishing. If no such linkages were developped, the catcher could simply sell his harvest to the trader who fetched the highest price.

- *Crab seed traders*

The number of large crab seed traders was estimated at 15 in Northern Samar (Muhia & Lutao, 2007) and 20 in Camarines Norte.

Age composition of the crab seed traders ranged between 26 and 55 with an average of 43. Experience in crab seed trading ranged between 2 and 18 years with an average of 8 years. Most traders were highschool or college graduated (80%). A minority were elementary graduated. All of the respondents had other sources of income in relation with the seasonnality of the availability of mud crab seeds. Among the thirteen respondents in the provinces supplying seeds, nine were engaged in other agriculture or/and fishpond operations while only four were engaged in other buy and sell businesses. In the culturing provinces, one trader was engaged in fishpond operations while the two others respectively earned from tricycle driving and a junk shop.

The common caracteristics of the traders in the supplying provinces was their access to capital to pay the seeds cash to the catchers, their access to family labor for handling and transport operations and finally their access to contacts in the culturing provinces. Starting capital commonly came from the other businesses ran, or from another family member. Among the thirteen respondents in the supplying province, one trader was borrowing money to an informal money lender. In the culturing provinces, crab seed middle men could be paid in advance by the fishpond operators or given credit by the traders in the provinces supplying the seeds.

The linkages of traders to the other key players in the sector were different depending on the strategy adopted. Some crab seed traders were specialised in collecting crab seeds from the catchers while some were specialised in exporting to the culturing provinces (Figure 10).

- Large traders collected the juveniles from a large number of catchers. They had enough family labour to handle, categorize and sometimes capture the seeds. They had access to fishponds for stocking the crabs if there was no order. The crabs were delivered to fishpond operators, middle men as well as other traders in different provinces. Some large traders would give a short credit to their customers to ensure their loyalty but the payment scheme was commonly cash on delivery.
- Crab seed collectors were gathering seedstock directly from catchers. They were located near the catching grounds and had access to a fishpond. Their only customers were other traders in the locality. Among the four crab seed collectors met, two were engaged in buying and selling marketable crabs and one was engaged in buying and selling wild-caught seeds of different cultured species. The last one had no access to family labour for handling the seeds. All collectors were paid cash on delivery.
- Crab seed exporters were supplied by collectors upon orders to limit losses. The number of key customers varied between three to twenty depending on the trader. Among the four crab seed exporter met, the two largest were engaged in other buy and sell businesses. The two others, handling less important volumes, were engaged in other agricultural activities.

- Crab seed middle men disperse the seeds shipped at their arrival in the culturing areas. Among the crab seed middle men met, all were connected to a unique trader in the province supplying the seeds. One middle man was a relative of a trader while the other was hired by one. Both were specialised in trading crab seeds. The last one middle man was dispersing all kind of seeds to fishpond operators and had no personal relationships with his suppliers.

• *Crab culturists*

In Camarines Norte, among the ten crab culturists interviewed, four were buying their seeds from traders in their locality and one was purchasing crabs directly from the seed catchers. The three others were catching the seeds themselves while two relied on the natural entry of the mud crabs inside the fishpond. In Northern Samar, most crab culturists bought their seeds direcly from the crab seed catchers or collected them themselves. In Pampanga, among the seven operators met, three were supplied with crab seeds by middle men, two by large traders or exporters and two by other fishpond operators (Figure 10).

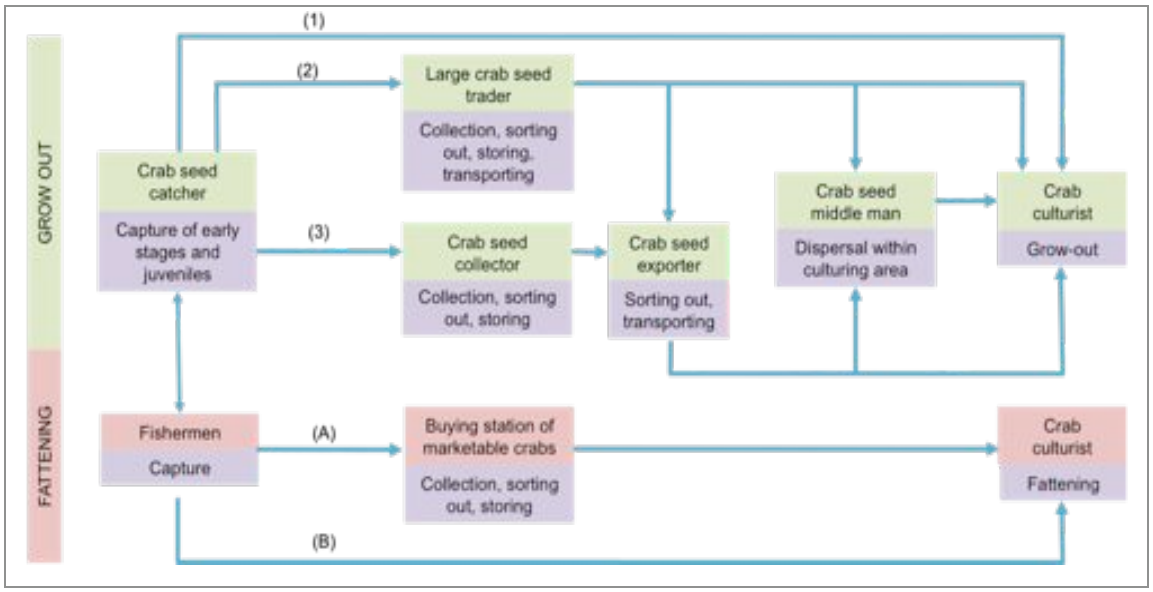

Figure 10. Mapping the key players, their role and links in the seed stock supply chain.

Juveniles caught in the mangrove by seed catchers can be sold to (1) crab culturists in the locality, (2) large crab seed traders or (3) crab seed collectors. Crab seed exporters are supplied by crab seed collector or large traders. Once in the culturing areas, crab seeds are dispersed by middle man or by crab culturists themselves.

c. Activities and costs

• *Crab seeds hatcheries and nurseries*

After hatching, mud crabs commonly display 6 larval stages; 5 pelagic zoeal stages, followed by one megalopa larval stage (M) prior to metamorphosis (C). Hatchery refers to the hatching of eggs and the rearing of the zoeal stages. Nursery refers to the rearing of seeds starting from megalopa stage.

Hatchery production relied on females with mature gonads sourced from the wild or obtained from buying stations. Females were subjected to unilateral eyestalk ablation and held in concrete tank until they were carrying eggs. Berried females were held individually until the eggs hatched.The first zoeae were fed with rotifers, which required the culture of phytoplankton. Newly hatched *Artemia* were fed to the late pelagic stage up to the juvenile stage. Large-scale production of natural food has been identified as one of the factor hindering commercial production but the major issue in hatchery production is the high mortality linked to the occurrence of vibrios at the late zoeae stage and cannibalism particularly at the megalopa stage. Mean survival rate of 3% was obtained from Z1 to 3 to 5 day old megalopa for *Scylla serrata* (Quinitio, 2003).

After 21 days, the megalopae were nursed in concrete tanks, cages in ponds (20m^2) or pens (500 m^2) at a density of 25 to 30/m^2. Trash fish, mussels, *Acetes* sp., and adult *Artemia* were fed twice daily to satiation. The survival rate was the highest with hapa nets in earthen ponds (35-50%) and pens (50%) compared to concrete tanks (15-26%). The growth rate was also highest in hapa nets compared to other technologies (Cerezo in Rodriguez & al., 2007 ; Quinitio, 2003). Traders storing fly size were indeed using cages in ponds.

Investment cost for hatchery/nursery were estimated at PHP 260,000 for a rented hatchery and PHP 1,150,000 for a hatchery using canvas tanks (SEAFDEC, 2010). In hatchery/nursery, breakeven price of the seeds were estimated at PHP 1.48 to PHP 1.84 per piece. Nursery technologies stocking megalopa or early stages catched in the wild required a less important capital with investment estimated at PHP 1,300 for a net cage and PHP 7,000 for a 500 m^2 pen. In nursery operations, net margins were estimated at PHP 1.3 up to PHP 3 per piece depending on the technology.

- *Crab seeds collection*

The sizes of crabs collected varied between early crab stages (2mm) to sub adult (75mm). In the early 1990s, most culturists in the Philippines used juvenile crabs of 20-30 mm CW (Carapace Width) for stocking (Angell, 1991). The catch of megalopa and early crab stage larvae has been first recorded in Taiwan and presumably extended in the Philippines in the lates 1990s (SEAFDEC, 1997). According to the operators, the catch of crabs under 20-30 mm started 5 years ago when it was getting harder to supply larger sizes.

Early stages are caught using a small meshed net mounted on a V-shaped bamboo frame and pushed across muddy substrates. Mud crab fisheries for larger juveniles and adults employ gear such as gill nets, trawls, traps or handpiking in the intertidal. The most frequently used gear are the baited traps (locally called « bobo ») and the lift nets (locally called « bintol ») (Figure 10). The crabs caught were then transported in platic bags, pails or basins for selling. The mortality rate between catching the seeds and selling them was estimated at 5%. Actual mortality was presumably much higher for the catch of early stages considering the high destruction associated with the use of push nets.

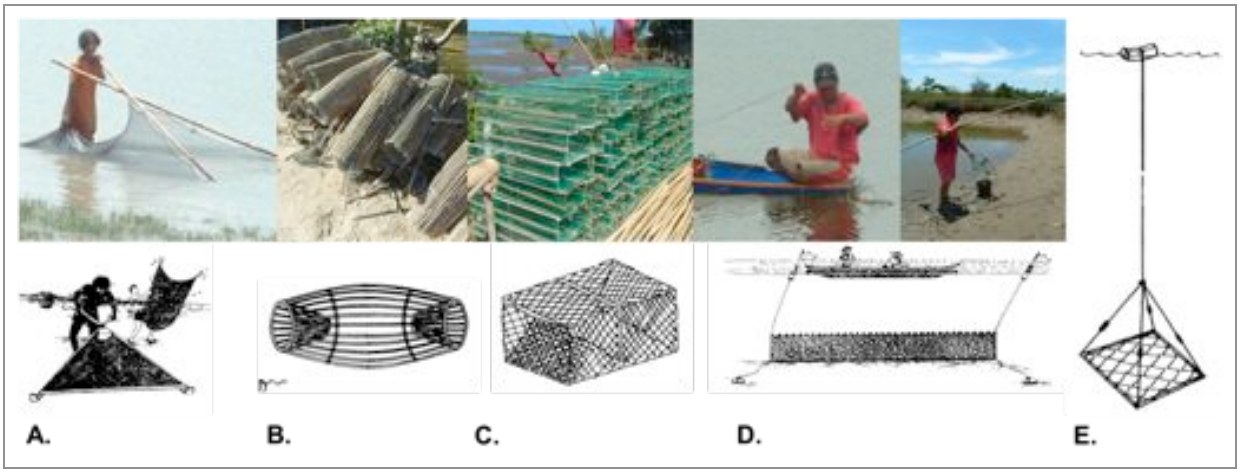

Figure 11. Mud crab catching. (A) Collection of early stages with a pushnet.(B) Baited bamboo trap. (C) Baited plastic trap. (D).Gillnet. (E). Lift net.

Seed catchers of early stages (< 25 mm) could harvest between 75 to 180 pieces/day in peak season. The average income was estimated at PHP 180/day with an average selling price of PHP 1.50/unit (Muhia & Lutao, 2007). Catch of crab seeds of 25 mm and above were evaluated at 13 and 53 pieces/day. Catchers could earn an average of PHP 118/day in low season to PHP 243/day in peak season with an average selling price of PHP 5 to 9/piece (Borero & Abordo, 2001). Prices depend on supply and demand.

- *Crab seed categorization and storing*

For counting and sorting by size, traders used plates and small sticks. For early stages, the species could not be determined and the traders relied on his experience of the seasonnality of recruitment to guarantee to the crab culturist a high proportion of *Scylla serrata*. For sizes above 20 mm, claws were systematically removed and the juveniles were sorted by species. Orders of *Scylla olivacea* were indeed larger sizes considering that the demand was much lower than *S. serrata*. Six categories of sizes were recorded. The first class was fly size (< 5 mm), followed by TX (< 15 mm, size of a 5 cents coin), triple (< 20 mm, 25 cents coin), double (<25 mm, PHP 1 coin), single (<30 mm, PHP 5 coin) and big or matchbox (< 75 mm, matchbox) (Figure 9). After categorization, the seeds were stored in basins commonly up to 2-5 days for collectors, up to 15 days for large traders. After this period, the crab seeds were transfered to boxes or happa nets or plastic nets in ponds to limit losses (Figure 11).

Figure 12. Crab seedstock storing. Depending on the size and on the storing durations, crabs are kept in basins, in submerged containers or in happa nets.

The main constraints in the supply chain of crab seeds was the high mortality during stocking. The frequent and asynchronous molt of early stages made them vulnerable to cannibalism. According to large traders or crab seed collectors, the mortality while stocking was variable depending on size. For « fly size » and « TX », mortality could be up to 20% in three days stocking, 10% for triple and double, and 0 to 5% for sizes above. Considering that the frequence of molting is decreasing when the size increases and that molting is asynchronous, the mortality linked to cannibalism was presumably higher for early stages. According to export traders, the mortality was equal for all sizes with an average of 10 to 15%.

Investment capital of the traders encompassed stocking gear and sometimes fishing gear. The costs and returns of collecting and storing varied widely depending on the season. The largest income was earned during the peak season of early crab stages considering the volumes at stake. Net income for « fly size » collection and storing was estimated at PHP 0.25 per piece with a turn over of 5,000 to 15,000 pieces a week. For single size, net margin was estimated at PHP 1.55 per piece with an average turn over of 500 piece per week.

- *Crab seed transport*

For transportation, « fly size » and « thumbtacks » were packed in cardboard covered with plastic, cheese cloth and a piece of happa net. Larger sizes could be transported in a cardboard on in a tray and covered with newspaper or leaves (Figure 12).

Figure 13. Crab seed transport. Depending on size, crabs are transported in cardboard or in plastic trays.

Crab seeds were transported by bus from Camarines Norte to the Northern fringe of Manila Bay overnight. From Northern Samar, crab seeds were transported by ferry boat to Sorsogon (Bicol-V) or to Roxas (Western Visayas-VI).

Crab juveniles were relatively easy to transport compared to other wild-caught seeds of cultured species. During transport, mortality was estimated at 1 to 5% for the early stages (<15mm), 1% for the sizes above.

Net margin from packing and transporting in culturing areas was estimated at PHP 0.88 per piece for fly size with a turn over of 5,000 to 50,000 pieces per week depending on the number of customers. For single size, net margin was estimated at PHP 1.54 per piece with 5,000 to 10,000 pieces ordered weekly.

- *Crab culturists*

In Camarines Norte and Northern Samar, most crab culturists engaged in grow-out operations were stocking matchbox size up to 125 g. Only one operator was stocking fly size. Stocking density was 1,000 pieces/ha on average.

In Pampanga, two farmers were stocking fly size and five were stocking single or matchbox size. These figures are probably not representative considering the importance of the production of fly size in the supply provinces. Considering that the average pond size in Pampanga is 24 ha (Irz, 2003) and that stocking density for mud crab was of 400 pieces/ha on average, average size of average was of 9,600 pieces.

- *Distribution of costs and earning along the supply chain of seedstock*

Major technical constraint in the supply chain of crab seeds appeared to be mortality while storing in relation to cannibalism. Reduction of storing duration and arrangements between traders and catchers could significantly reduce mortality.

The biggest income was earned with transport considering the volumes at stake. Catchers earned the most on a per piece basis unlike other fry supply chain where prices are controlled by traders.

		catch	collect, store	transport	disperse	stock in ponds	total
Fly size	*duration*	1 day	3-15 days	2 to 3 days	same day	same day	6 to 19 days
	mortality	5%	5%-50%	5-15%	-	40%	50 – 75 %
	cost per piece	-	PHP 1.50	PHP 2.00	PHP 3.00	PHP 3.50	-
	net income per piece	PHP 1.50	PHP 0.25	PHP 0.88	PHP 0.50	-	-
	volume in peak season	75-180 pieces/day	5,000 pieces/ week	50,000 pieces/ week	50,000 pieces/ week	10,000 pieces/ stocking	-
Single size	*storing duration*	-	-	-	-	-	-
	mortality	1%	5%	1%	-	40%	55%
	cost per piece	-	PHP 7.00	PHP 9.00	PHP 11.00	PHP 12.00	-
	net income per piece	PHP 7.00	PHP 0.88	PHP 1.64	PHP 1.00	-	-
	volume	13-53 pieces/day	500 pieces/week	5,000 to 10,000 pieces/week	5,000 to 10,000 pieces/week	10,000 pieces/stocking	-

Figure 14. Distribution of costs (mortality, transport) and income (net margin, volumes) along the supply chain of seedstock

d. External influences

- *Regulation of crab seed collection*

Unlike in Australia and South Africa, where mature and egg-bearing mud crabs are protected, in most Southeast Asian countries no such regulation exists at a national level.

In Camarines Norte, regulation of the collection of crab seeds exists at a local level through the implementation of ordinances. Some barangays have delimitated « crablet sanctuaries » but no municipal, provincial or national regulations have been mentionned during interviews.

- *Regulation of crab seeds trading*

In Northern Samar and Camarines Norte, provincial ordinance are banning the export of crab seeds under 75 mm outside the province. The regulation has not been implemented in Camarines Norte but the smuggling of seeds outside Northern Samar is monitored.

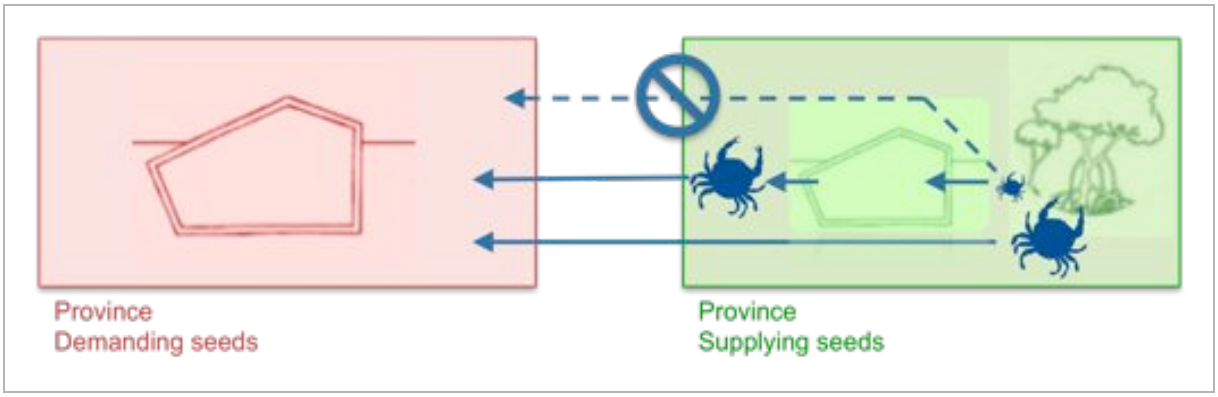

Figure 15. Illustration of the regulation of crab seeds trading in the provinces supplying seeds. Early stages can be caught but must be nursed up to 75 mm before being exported outside the province. Crabs caught at a size of 75 mm up can be directly exported.

III. 4. The mud crab culturists

a. Relative importance of mud crab culture

- *Environmental conditions*

Mud crabs naturally occur in established mangroves and can be cultured in earthen ponds and in mangrove integrated pens.

Favorable conditions for mud crab culture in earthen ponds are a sandy clay or clay loam soil with a rich organic matter base, and preferably alkaline. A good water quality coming directly from the sea or a tidal river should be available all year round. The most desirable ranges of water quality are as follows : salinity 10-34 ppt, temperature 23-30°C, dissolved oxygen above 3 ppm and pH 8.0-8.5 (6) (Baliao, 2000). Ponds were built on mangrove swamps or tidal mudflats sites.

The mangrove area selected for culturing mud crabs should be unpolluted and have a water depth of 0.8 to 1 m at high tide. Areas that are susceptible to large ways should be avoided. Salinity should range from 10 to 30 ppt and temperature from 25 to 30°C (Baliao, 2000).

- *Geographical distribution*

Mud crab is commonly cultured in brackishwater ponds which represents 92.5% of the total production. Mud crab culture in pens and cages in mangrove and estuaries represents only 0.4% of the national production while capture accounts for 7.2% of the production (BAS, 2008).

The main provinces producing mud crabs in ponds are Pampanga (Central Luzon), Lanao del Norte (Northern Mindanao) and Sorsogon (Bicol Region) accounting for 79% of mud crab culture production (Table 5). Producing areas are located in relatively sheltered bays. In the Western Visayas, which has the largest area of brackishwater ponds in the country, mud crab production represents only 2% of the national production (Appendix 9). Camarines Norte and Northern Samar are minor culturing provinces respectively accounting for 1% of the national production despite the importance of brackishwater resources.

Table 5. Mud crab culture production in the Philippines. Culture in pens and cages are still marginal. Culture in brackishwater ponds accounts for 99.6% of the national production.
Source : BAS, 2008

Brackishwater ponds			**Pens and cages**		
	Volume (m. t.)	**Value ('000 PHP)**		**Volume (m. t.)**	**Value ('000 PHP)**
1. Central Luzon (III)	**3,390.92**	**787,135.16**	**1. Ilocos (I)**	-	**0.80**
Pampanga	*3,210.47*	*752,514.86*	*Ilocos Norte*	-	*0.80*
2. Northern Mindanao (X)	**3,397.45**	**967,637.74**	**2. Eastern Visayas (VIII)**	**6.50**	**487.50**
Lanao del Norte	*2,945.83*	*880,925.24*	*Eastern Samar*	*6.50*	*487.50*
3. Bicol Region (V)	**1,551.36**	**345,034.29**	**3. Northern Mindanao (X)**	**0.36**	**140.55**
Sorsogon	*1,185.48*	*266,569.59*	*Camiguin*	*0.36*	*140.55*
Total	**9,267.16**	**2,292,703.95**	**Total**	**6.86**	**628.85**

b. Accessing factors of production

Key players in crab culture production are the land owners, the financers and the caretakers who respectively hold land, capital and labour. The farmers make decisions and choice to organize and operate the farm. The owners, the financers and the caretakers were not specifically met considering that the farmer was the key informant regarding production but data was gathered regarding these key players through the glance of farmers.

- *Access to land and resources*

Access to land area is a prerequisite for pond farming and integrated mangrove aquaculture. Farmers have access to ponds through private ownership, lease arrangement with a private owner or lease from the government. Between 1973 and 2009, out of 239,323 ha of brackishwater fishponds, 61,066 ha had been leased by the BFAR (Bureau of Fisheries and Aquatic Ressources) under FLA (Fishpond Lease Agreement). Private ownership was the dominant land tenure regarding fishponds. Occupation of mangrove for pens and cage culture required an authorisation from the government. Only in Northern Samar were some farmers culturing crabs in the mangrove. One private operator and one NGO had respectively obtained a permit from the LGU (Local Government Unit) and from BFAR (FLA).

- *Private ownership*

The highest number of farmer-owners was found in Camarines Norte with six farmers out of ten owning their fishponds. Acquisition time ranged between 1980 and 2004. Five of them had purchased an area covered with *Nypa fruticans* and developped it into fishponds. Only one respondent had purchased an already converted area from an operator originated from Bulacan in Central Luzon (major producing province in brackishwater ponds) for PHP 30,000/ha. According to the respondents, title deeds were provided by the DENR (Department of Environment and Natural Ressources).

In Northern Samar, two farmers were owning a fishpond. They had respectively purchased and developped their land into fishponds in 1985 and 2004. It should be noted that in Camarines Norte and Northern Samar, fishponds were not built with the help of machines but man made. Cost of construction was estimated between PHP 300,000 and 400,000 per hectar.

In Pampanga, three farmers out of seven were also owners. Fishponds had been inheritated or purchased thanks to successful operations but the last pond was presumably built in the 1980s, at the time of the prawn success. Current price of land was of PHP 800,000 to 1,000,000/ha. Land was titled by the DAR (Department of Agrarian Reform).

- *Leasing from a private owner*

In Pampanga, four farmers out of seven were yearly leasing their fishponds for PHP 25,000 to 30,000 per ha.

In Camarines and Northern Samar, respectively three and one farmer were operating a land owned by a friend or a relative. Arrangements were commonly payments in nature (fish, crustaceans) or in the form of a percentage of the harvest for those who were also financed by the owner. None of them were paying a fixed rent.

- *Leasing from the government*

Only in Northern Samar was land leased from the government. One farmer had been leasing thirty hectars from BFAR under FLA for more than 50 years. Two farmers had been granting a permit from the LGU to operate areas under one ha. One farmer was operating on public land despite interdictions.

- *Access to credit and financial services*

Farmers access financial capital through household finance and savings, income from other activities and formal and informal credit sources.

- *Household finance and savings*

In Camarines Norte, eight out of ten farmers relied on their own savings to start aquaculture operations. Six farmers were engaged in other fisheries/agriculture operations, one was running other businesses (small shop, jeepney driver). The farmer owning the largest area was engaged in fishpond operations only.

In Northern Samar, six out of seven farmers relied on their own savings. Two households were engaged in other agricultural and fisheries activities, three were formal employees (municipality, barangay Council, lawyer), and one was operating a milkfish processing plant. It must be noted that the interviews were conducted based on a list established by institutions (Municipality, Barangay) so that these figures are probably not a fair representation of the farmer's other activities.

In Pampanga, operators venturing in fishpond operations usually rely on external fundings to supplement their own savings.

- *Informal credit sources*

In Camarines Norte, one operator was punctually financed by a relative, the financer being the owner. One farmer was in partnership with a friend for financing and ownership. Existing financer-farmer sharing arrangements inludes sharing of net profit 50 :50, 60 :40 up to 90 :10 in favor of the financer. In Northern Samar, one farmer had received help for developing his area, in the form of labour capital more than financial capital. In Pampanga, two farmers were financed by friends/relatives with no interest rate.

In Pampanga, buying station were an important financer of culture operations. Buying stations could lend PHP 100,000 to 200,000 per farmers. Arrangement was an interest rate of 5% and the guarantee that the farmer would sell his harvest to the said buying station. In Camarines Norte, a buying station operator had also helped some of his relatives to venture in fattening operations but the practice was not considered common.

None of the farmers had recourse to formal credit sources. In Northern Samar, NGOs and BFAR had been financing pond rehabilitation and operations for communities on a project basis.

- *Labor and employment*

Aquaculture generates employment on the farm, either on a full-time basis when a 'caretaker' is responsible for the day-to-day farm operations, or on a more occasional basis for seasonal tasks, such as harvest or feed collection. The difference between the caretaker and the farmer relies in the decision making and the risk taken.

In Camarines Norte, among the ten farmers, four farmers were hiring a caretaker on a full time basis. In Northern Samar, two farmers out of seven were hiring a care-taker. In Pampanga, all the farmers were hiring caretakers at an average of one caretaker per 10 hectars. Farmers were also hiring workers for harvest on a daily basis. Large farmers were hiring full-time workers solely for the purpose of collecting feeds in the nearby riverbeds.

The remuneration of caretakers has several components, including a base monthly salary (around PHP 3,500 – 5,000 in Pampanga and PHP 1,500 - 2,500 in Camarines Norte and Northern Samar), incentive payments in the form of a percentage of the harvest (typically 10% in Pampanga up to 50% in Camarines Norte), as well as payments in nature (provision of free housing, rice and fish) but arrangements varied from farm to farm. For the harvest of natural feeds, arrangement was usually 60% of the net income for the labourer and 40% for the farmer owning the boat. Daily workers were paid PHP 300 to 600 depending on the province.

- *Assessment of the access of the farmer to factors of production*

In Camarines Norte, most fishponds were privately owned. Farmers had enough capital to convert mangrove into fishponds. It seems that access to mangrove area was not carefully conserved. A number of farmers were operating fishponds without paying a rent suggesting that competition for fishpond use is low.

In Northern Samar, the majority of the farmers were operating land under the jurisdiction of the government because of difficulty to access capital for developping their own fishponds. It is also possible that the sampling was not representative of the situation. Few operators had managed to build relatively small fishponds or pens in the mangrove thanks to help from family labour and capital.

In Pampanga, majority of the farmers were leasing their fishponds to land owners for a fixed amount. Cost of land was relatively high in Pampanga because of competition for accessing fishponds presumably related to high economic performances of the farms. Operations were economically supported by buying stations who gave credit to farmers to ensure their supply.

Table 6. Access of the farmers to factors of production in the surveyed provinces.

	Land and resources	Credit and financial services	Labor and employment
Camarines Norte (10)	- Private ownership – built on mangrove (5) - Pond leased from a private owner, no rent (3)	- Own savings & income (8) - Friends and relatives (2)	- Family labour - Full time caretakers (4)
Northern Samar (7)	- Leased from the government (2) - Private ownership – built on mangrove (2) - Leased from a private owner, for free (1)	- Own savings & income (6) - Friends and relatives (1) - Government fundings	- Family labour - Full time caretakers (2)
Pampanga (7)	- Leased from private for PHP 30,000/ha (4) - Private ownership – inheritated or purchased (3)	- Own savings & income (3) - Credit from buying stations - Friends and relatives	- Full time caretakers (7)

c. Technology and economics of mud crab culture

- *Relative importance of mud crab culture systems*

Mud crab culture stock early stages or juveniles as well as low quality crabs. Grow-out system has evolved from low-density pond polyculture with fish (Lijauco & al., 1980) using wild seeds introduced tidally or intentionally, to monoculture in smaller ponds, pens and cages (Baliao & al., 1981 ; Agbayani & al., 1990) and more recently to integrated mangrove-crab systems (Triño 1999). Mud crab can also be fattened : thin crabs, or post moult or « water crabs » are kept for a short period until they flesh out as mentionned earlier. Fattening can be conducted in bamboo enclosures in ponds or rivers or mangrove as well as in pond-based systems surrounded by nets. Mud crab fattening was probably developped in the 1990s, primarily to meet the demands of the domestic and foreign markets (Samonte & Agbayani, 1992).

In 1975, a socioeconomic survey on crab farming in The Philippines was undertaken by the SEAFDEC and the PCARRD (Philippine Council for Agriculture and Resources Research and Development). The study showed that out of a total of 61 respondents from all major crab-producing regions operating a total pond area of 44.45 ha, only four respondents, with an aggregate pond area of 8.27 ha, were engaged in mud crab monoculture. The rest were in polyculture with milkfish, prawns, and other species (Lapie & Librero, 1979 in Agbayani, 1990). The current situation in still the predominance of polyculture in ponds. Secondary data available for Bicol region shows that out of 215 respondents operating a total area of 1,210.51 ha, 164 (76%) were engaged in grow-out in polyculture, 12 (6%) in grow-out in monoculture, 26 (12%) in fattening and 13 (6%) in nursery operations (Buitizon & al., 2003). In Northern Samar, among the 21 operators interviewed by Muhia & Lutao (2007), 10 were engaged in crab fattening and 11 in mud crab growing with no specificity on the culture system used. In Pampanga, mud crab production mostly relied on polyculture systems with milkfish, prawns and tilapia.

- *Mud crab in polyculture in brackishwater ponds*

The main culture system of mud crab production was polyculture in brackishwater ponds. Among the twenty four farmers met, all of the respondents were engaged in polyculture operations in Camarines Norte, five out of seven in Northern Samar and all the respondents in Pampanga.

- Pond layout and design

Average land area of brackishwater pond area in Pampanga was 24 ha (Irz, 2003). Pond construction and rehabilitation was mechanized (Figure 16).

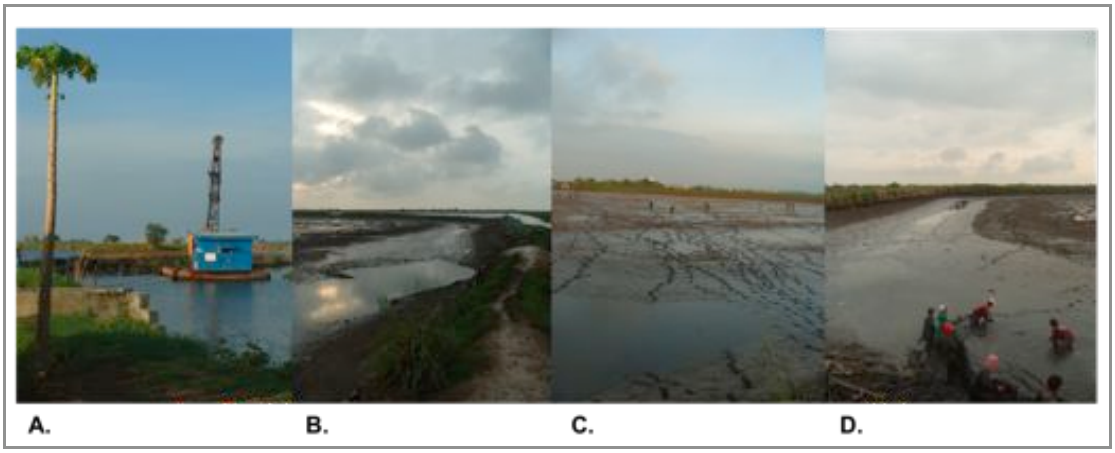

Figure 16. Brackishwater pond for polyculture in Pampanga. (A) Excavator placed in the river nearby the ponds to solidify the dykes. (B) Trenched canals dug parallel to the dykes to avoid exposure of shimps and crabs to high temperature and make harvest easier (C) Harvesting crabs by hand. (D). Harvesting fish in the canal with a net.

In Camarines Norte and Northern Samar, land area of the farmers ranged between 0.5 ha to 13 ha with an average of 2.88 ha. Manual excavation was a common practice (Figure 17).

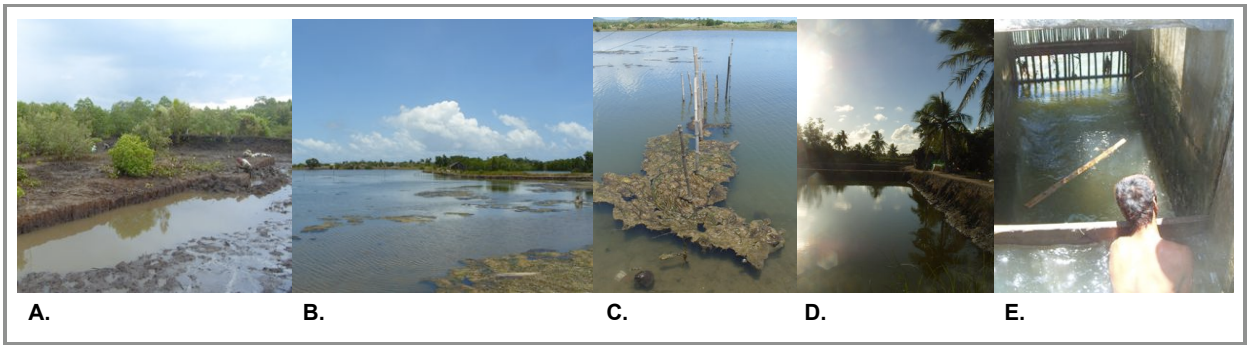

Figure 17. Brackishwater ponds for polyculture in Camarines Norte and Northern Samar. (A) Manual fishpond construction in Northern Samar. (B) Large fishpond in Camarines Norte. (C) Natural food colonizing the pond (« Lumut »). (D) Small fishpond in Camarines Norte. (E) Water gate in a polyculture pond.

- Pond preparation

Prior to fish stocking, Tea-seed (saponin) and Sodium Cyanid (NaCN) were applied to eradicate obnoxious pests and nuisance organisms. Sodium Cyanid is banned but still available and applied. Ponds were then partially filled and chemicals were added to encourage the growth of natural food. In Pampanga, operators used urea, lime and more seldomly plancton stabilizers (Aquapond©). Natural food included « lab-lab », « lumut » (Figure 17) (*Enteromorpha clathrata*) or « digman » (*Hydrilla verticellata*). Lab-lab is a mixed benthic algal microorganism and animal community. It often includes several species of bacteria, blue-green algae, diatoms, protozoa, copepods, amphipods, ostracods, nematodes, polyaetes, molluscs, cladocerans, isopods and other organisms (Baliao, 2000). In Camarines Norte and Northern Samar, very few operators were using Ammonium Phosphate (16/20/0) to encourage the growth of lumut.

- Associated species

In Pampanga, mud crab were cultured with milkfish, tiger prawns (*Penaeus monodon*) or white leg shrimps (*Penaeus vannamei*), and tilapias. Among the seven farmers interviewed, three had chosen to stock the tiger prawn and three had chosen the white leg shrimp. The last operator was stocking both species depending on the compartment.

In Camarines Norte, among the ten respondents engaged in polyculture, one farmer was not buying seeds and relied on their natural entry in the fishpond. Among the nine farmers using supplemental stocking, all of them were stocking milkfish, eight were stocking mud crabs and three were stocking tiger prawns. Reasons for not stocking mud crabs could be their high escape rate or the necessity to hire a caretaker because of easy poaching. In Northern Samar, among the five farmers engaged in polyculture, all of them were stocking milkfish and mud crabs. Only one farmer was stocking tiger prawn. None of the farmers in Camarines Norte and Northern Samar were stocking tilapia because of high salinity in the water.

- Stocking

Stocking size for grow-out in polyculture ponds started from early stage (10 mg) up to 125 g. Stocking rates for mud crab growing were commonly 0.5 to 1.5 crabs/m^2 in experimental trials, 0.05 to 0.1 crabs/m^2 in the surveyed farms (Appendix 9). When mud crabs were cultured at higher densities, mortality presumably linked to cannibalism, significantly reduced the harvest.

In Pampanga, culturists prefered to stock single size rather than early stage because of a shorter culturing period. Crabs were cultured four months for single size and six months

for fly size. On average, stocking density was of 400 pieces/ha. Culturists prefered to stock white crabs. However, low salinity in rainy season could increase mortality of the early stages of these species. Some farmers chose to stock red crabs (*Scylla olivacea*) more tolerant to low salinity. Some farmers sotcked white crabs before the rainy season started since adults are more tolerant to salinity variation.

In Camarines Norte and Northern Samar, culturists prefered to stock white crabs of 125 g. Average stocking density was 1,000 pieces/ha. In rainy season, crabs were seldomly stocked because of flooding and typhoons issues Mud crabs were cultured six months to one year in Camarines Norte and Northern Samar despite a large stocking size.

- Feeding

In Pampanga, feeds were collected from nearby riverbeds and distributed to shrimps and crabs in addition to the natural production of the water. Common items were sea snails (*Cerithadia sp.*) locally named « suso » ; mussels (*Modiolus sp.*) or « tahong » or gasang (Figure 18). In Camarines Norte and Northern Samar, farmers who did not stock tiger prawn were usually not supplementing the crabs with feeds but the pond was naturally colonized with shells. When crabs reached a marketable size, they were transfered to fattening ponds.

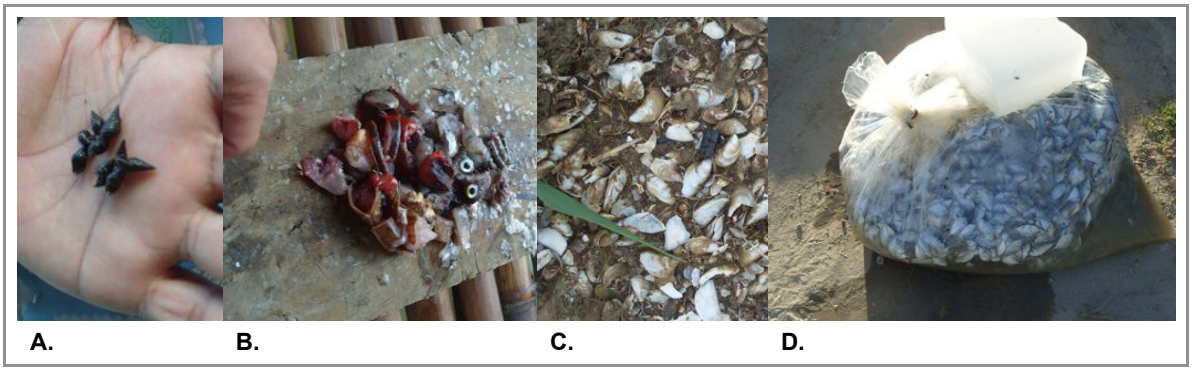

Figure 18. Feeds distributed to crustaceans. (A) Gasang. (B) Chopped trashfish. (C) Mussels. (D) Trashfish or Sap sap (ponyfish).

- Production in volume and value

Technical and economical performances of the farms were easier to access in Pampanga than in the other provinces. However, the results obtained in this province are unusual and can not be extended to other provinces in the country as mentionned earlier.

In Pampanga, mud crab annual production was estimated at 192 kg/ha/yr. Overall production of the fishpond was estimated between 1,357 kg/ha/yr and 1,576 kg/ha/yr depending on the species and survival rate (Appendix 9). The higher production in volume was obtained with the white leg shrimp (Figure 19).

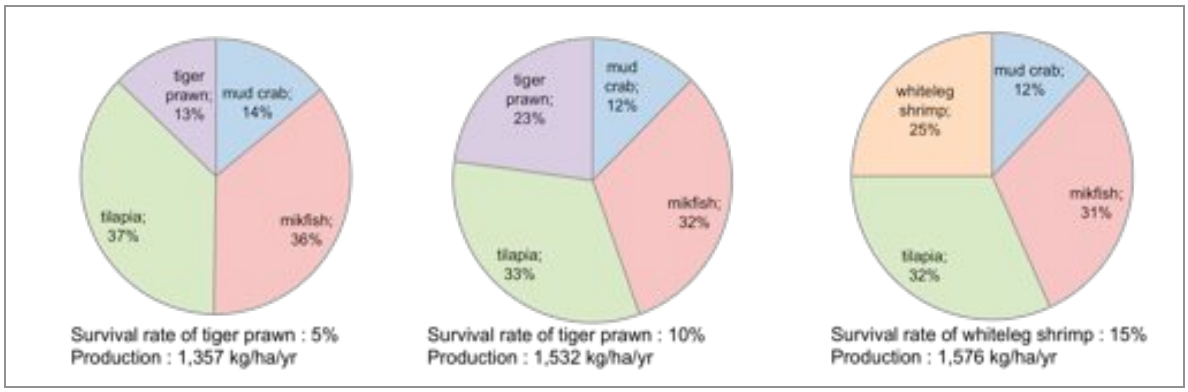

Figure 19. Tentative estimation of the importance in volume of mud crab in polyculture in Pampanga. The survival rate displayed correspond to the results commonly obtained by farmers in the province. Milkfish and tilapia account for the majority of the production in volume. Crustaceans are minor productions. White leg shrimps has the most important share among the crustaceans.

Income from fishponds in Pampanga varied widely depending on the mortality rate of shrimps and prawns ranging between PHP 95,000/ha/yr up to PHP 130,000/ha/yr (Figure 20). With a survival rate of 15% for *P. vannamei*, annual income was estimated at PHP 130,000/ha/year. Income with tiger prawn ranged from PHP 95,000 to 165,000/ha/year with survival rates of 3 to 10%. Depending on the survival of the prawns and shrimps, mud crabs could represent 19 to 27% of the income while prawns were representing 34 to 53%. In 2003, Irz reported that shrimps accounted for 62% of the income, and milkfish for 17%. It seems that the profit from shrimp production has been decreasing linked to low survival and decrease in prices. Crab production has not been increasing in volume or value because practices are the same as ten year ago (Diener, 2000) but its relative importance has increased in relation to prawn low survival.

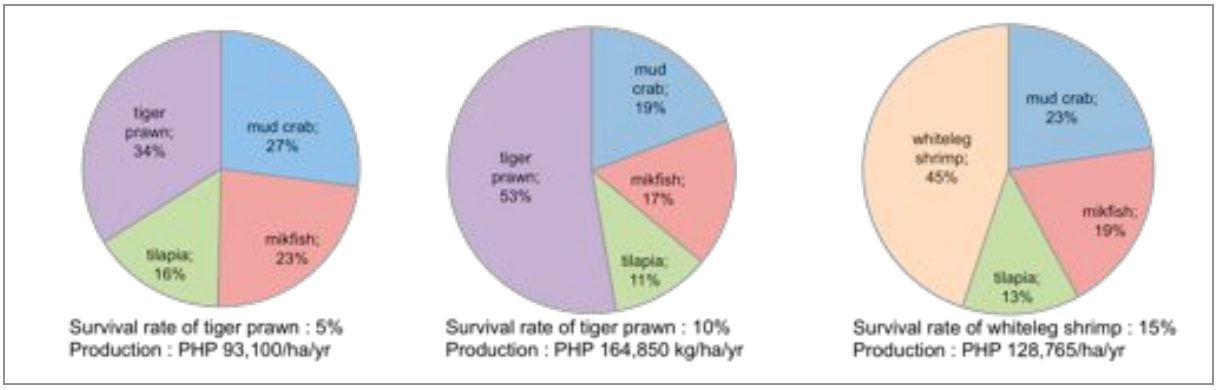

Figure 20. Tentative estimation of the economical importance of mud crab in polyculture in Pampanga. Depending on the survival rate of the prawns and shrimps, mud crab could represent up to 30% of the income. This percentage was not as high as expected.

In Camarines Norte and Northern Samar, average production was estimated at 930 kg/ha/year with no tiger prawn stocked and 1,186 kg/ha/year with tiger prawn. It should be noted that this data mostly relied on the perception of the farmer since most fishponds were not drained for harvest. According to the farmers, the income was largely dominated by crabs. In Camarines and Northern Samar, it seems that mud crabs were economically structuring polyculture since stocking densities and survival were higher than in Pampanga and that tiger prawn was seldomly cultured.

- *Mud crab monoculture and fattening in brackishwater ponds*

  - Pond layout and design

Monoculture and fattening pond area ranged between 150 to 500 m^2. The area was usually fenced with bamboo slats and nylon nets to prevent crabs from escaping. In Northern Samar, it seems that farmers were advised by experts since most of them had provided the crabs with earthen mounts for breathing, and PVC pipes as burrow substitutes. An NGO had also been dispersing a technology where crabs are individually tied to a bamboo slat (Figure 21). These structures were seldomly observed in Camarines Norte.

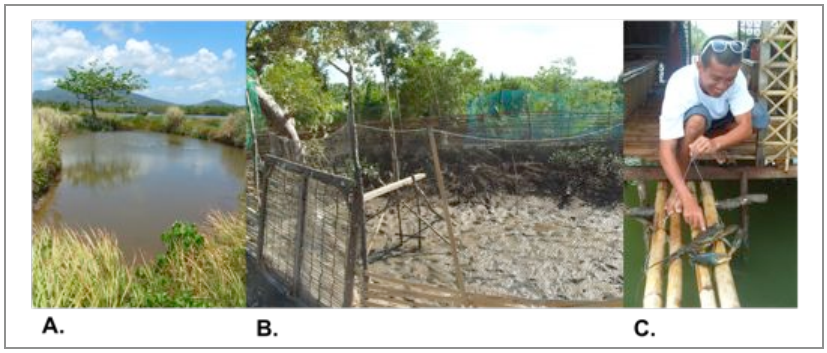

Figure 21. Mud crab monoculture and fattening in brackishwater ponds. (A) Small brackishwater pond in Camarines Norte with no fences. (B) Brackishwater pond in Camarines Norte with fences. (C) Tie crab technology in Northern Samar.

- Stocking and rearing

Mud crab fattening was practiced in Camarines Norte and Northern Samar but not in Pampanga. In Camarines Norte, out of the ten operators engaged in polyculture, five were fattening their crabs in small ponds before marketing. The size of the crabs was indeed a marketable size. It is believed that this process was not necessary in Pampanga considering the hight feeding rate and the low stocking density. In Northern Samar, among the five farmers engaged in fattening, three were growing crabs in polyculture and one was a fisherman. Fattening practiced by fishermen could also be considered as monoculture since subadults and adults were stocked.

Stocking rates were commonly 0.5 up to 5–7 crabs/m^2 but varied widely depending on the farmers, the fishermen and on the season. Crabs were kept fifteen days to one month and fed with trashfish or mussels. “Trash fish” was identified as the portion of the bottom trawl catch, mainly composed of the young or juveniles of commercially important fish species, as well as low valued food fish species such as slipmouths (Leiognathidae).

- Production

Production varied widely depending on the stocking density. Survival of the crabs in enclosures was between 50–90%. The wet-weight feeding rate was 5-10% per day.

The cost of thin crabs was a major input of operational costs. The thin crabs were bought PHP 120/kg and fed for PHP 50/kg. Operationnal cost was indeed estimated at PHP 170/kg. Crabs were sold PHP 350/kg meaning a margin of PHP 90 to 180/kg depending on the mortality rate. Net income from the pond depended widely on the stocking density, and indeed on the harvest from the wild or from the ponds.

The main difficulty of monoculture/fattening of mud crabs was the seasonnality of the availability of thin crabs and feeds, cannibalism and a constant attention related to easy poaching.

- *Mud crab monoculture and fattening in mangrove integrated pens*

Mud crab culture in pens was dispersed by NGOs in Northern Samar because this technology was considered as environmentally friendly and could provide additional income for coastal communities. One private farmer using this technique was surveyed in Northern Samar but none in Camarines Norte.

Net enclosures (Figure 32) could be constructed by driving long wooden bamboo poles in the sediment. Canals were digged to maintain the depth requirements for the cultured species in between mangroves not to damage the main roots nor to cut it.

Figure 22. Mud crab culture in mangrove integrated pens. (A) State project (B) Private

Operators stocking mud crabs in monoculture ponds or pens were using similar practices regarding stocking density or feeding rate. An additionnal difficulty was however the resistance of such structures to weather events.

d. External influences

In Camarines Norte, one farmer's association was mentionned during interviews. MFOA (Mambalite Fishpond Owner Association) aimed at lending money to fishpond operators with an interest rate of 5% but none of the members had been able to get a credit from this cooperative. In Pampanga, farmers were informally organized in groups.

III. 5. The mud crab traders

a. Relative importance of mud crab consumption

Among the 10,000 m. t. of mud crab produced in the Philippines, the export of live crabs was estimated at 1,700 m. t. (BAS, 2008, Appendix 10). The export data did not specify the species but *Scylla sp.*were believed to be the only one sold live according to the exporters.

Around 8,300 m. t. of live crabs are yearly sold in the domestic market meaning less than a hundred grams per capita. Considering the high value of mud crabs, Manilla supposedly remained the main market for crabs, with its restaurants and hotels as the primary consumption points. Household consumption in retails markets all over the country occured during special occasions (Holy Week, Christmas, New Year, local celebrations).

Mud crab export companies were mostly located in Parañaque City (National Capital Region) near the international airport of Manila. Main destinations for the export of live crabs were Hong Kong (854 m. t.), Singapore (531 m. t.) and Taiwan (222 m. t.) where Chinese communities are relatively important.

b. Key players, their roles and their links

Mud crab marketing practices were similar in the surveyed areas. In the three provinces, crab culturists could sell their harvest to a buying station in relation with export and local wholesalers (*1*, Figure 23). In Pampanga, crab culturists could sell their crabs directly to an export wholesaler *(2)*. In Camarines Norte and Northern Samar, some farmers were selling directly to local wholesalers or consumers *(3)*.

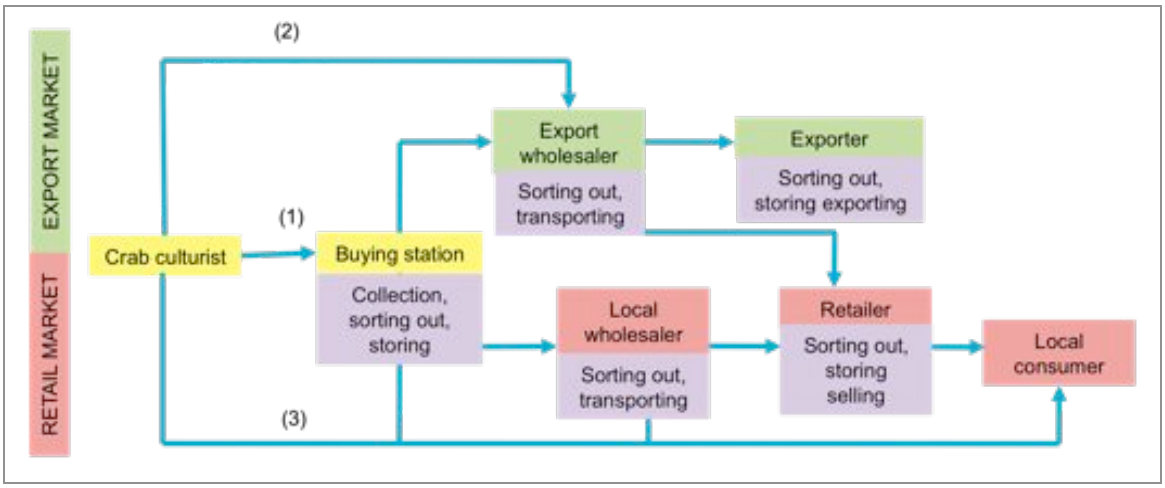

Figure 23. Mapping the key players and links of the mud crab marketing channels.

- *Crab culturists*

Mud crab culturists could sell their harvest to a buying station, to a wholesaler or directly to the consumer.

In Camarines Norte, among the ten respondents, two were selling their harvest exclusively to friends and relatives. The eight others were selling their harvest to local buying stations, to wholesalers in Calawag (Quezon Province) or to wholesalers in Quezon City (National Capital Region) depending on the volume harvested. The more important the volume was, the further were the crabs transported because of higher prices.

In Northern Samar, among the seven respondent, four were selling their harvest directly to consumers. The three other farmers were selling their harvest to a buying station within the province. It can be noted that fishermen met in a remote area were selling their crabs through a middle man.

In Pampanga, farmers were selling their harvest to buying stations or directly to export wholesalers depending on the volume harvested.

- *Buying stations*

The buying stations for aquatic products were first developped for capture fisheries. The buying station was the place where fishermen coming from the river or the sea, and buyers, coming from the road, met. These structures are now handled by agents who supervise the delivery and payment of product.

In Camarines Norte and Northern Samar, respectively four and two buying station agents were met. Mud crab marketing channels were distinct from other aquatic products. Buying stations were usually handled by one operator. Producers would come to the warehouse and were paid cash for the crabs. Depending on the price offered, the mud crab producer could decide to go to another buying station.

In Pampanga, fish, shrimps and crabs were sold in the same buying stations. The fishpond operators would deliver their products to the buying station's custody, in order for it to be sold, hence the local name « consignations ». The consignations buying mud crabs in Central Luzon were located in Masantol, Sasmuan, Guagua (Pampanga) and Orani (Bataan). In Hagonoy (Bulacan), the priority commodities were shrimps and prawns. To ensure their supply, a common practice for the consignation was to give credit to selected farmers as mentionned earlier. Prices were decided by bidding. Each wholesaler would whisper his price to the bid taker, the highest bidder getting the product.

Figure 24. Buying station in Pampanga. (A-B) Wholesaler observing the sorting out of the mud crabs. (C) Bidding by whispering.

- *Wholesalers*

Wholesalers bought crabs in large quantities from buying stations for them to be retailed by others.

In Camarines Norte and Northern Samar, retailers in the local market would buy their crabs directly from buying stations. Wholesale for export were located in Manila and Calawag (Quezon provinces) and would order crabs from buying stations. Indeed, no wholesalers were met in Camarines Norte and Northern Samar.

In Pampanga, out of the four respondents, three were export wholesalers and one was a wholesaler for the local retail market. Local wholesalers were buying all sorts of aquatic products and transported them to retail market in the province. Export wholesalers were specialized in crabs. They would buy the highest quality and deliver to the exporter in the first place. The rejects from the export would be sold in the retail markets nearby. Export wholesalers usually have employees for bidding, handling, packing and transporting.

- *Retailers*

Only two retailers were met in Camarines Norte. Retailers bought small quantities of crabs from wholesalers and sold them to consumers along with other aquatic products.

- *Exporters*

Sixty seven export companies were recorded by BFAR (Appendix 11). Only one exporter was met in Manila. The company was not specialised in mud crabs and was exporting other aquatic products. The capital of the company came from an importing country.

c. Activities and cost

Data regarding the costs and margins of the operators engaged in trading marketable size was sometimes difficult to access.

- *Sorting out*

Mud crabs were categorized by species, weight, sex and quality (Figure 24).

Figure 25. Sorting out the crabs in the buying station in Pampanga. (A) Tying the mud crabs. (B), (C) Classifying by species, sex, weight and quality. (D) Weighting the lots.

Two species are referenced : white and red crab. Three sex are referenced : male, female and immature female (or « bakla »). The crabs were also sorted upon quality by inserting a knife in the carapace interstice as shown in Figure 25. The fat of « bakla » was considered good when it was yellowish while females were appreciated for their ripe orange ovaries.

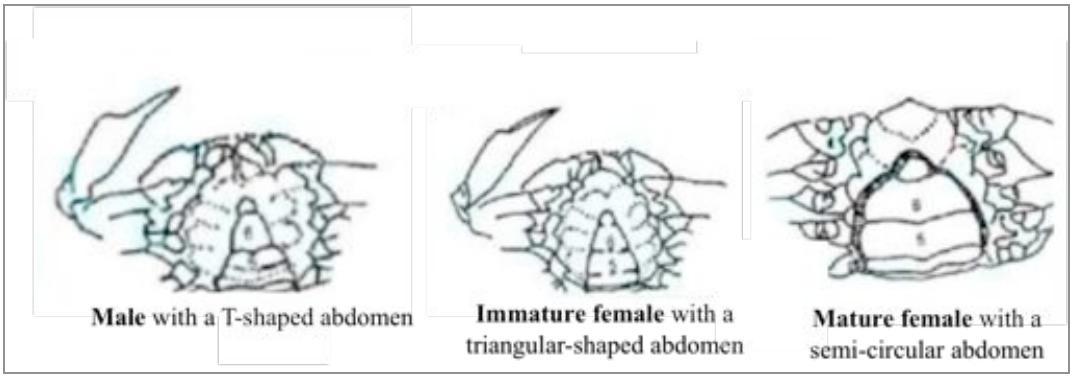

Figure 26. Mud crab classification by sex.

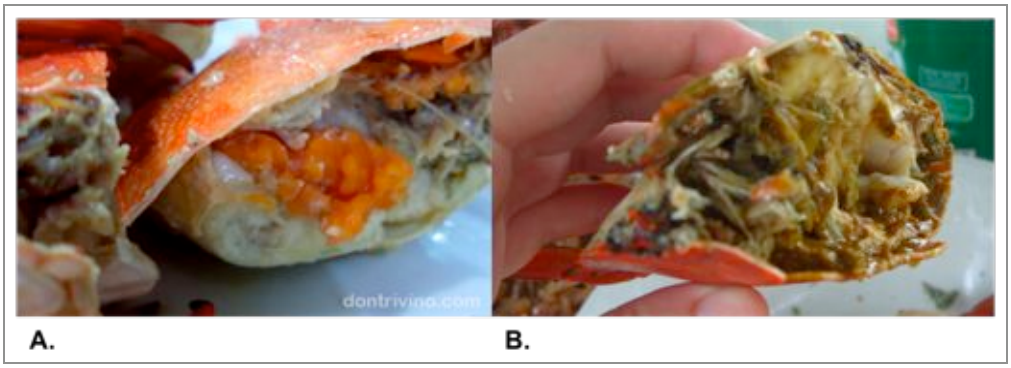

Figure 27. Mud crab classification by quality. (A) Orange ripe ovaries. (B) Yellowish fat of immature females.

The crabs considered as rejects were ones with a missing claw or a scar ; the thin crabs.

Exportable crabs were the white crabs. For males, minimum weight for export quality was of 500 g to 600 g and immature females had to weight more than 200 g to 250 g. Females, referred as « out of size », had to weight more than 300 g. Export quality also implies a good quality of fat. According to the exporters, red crabs are also appreciated by consumers in Hong Kong, Taiwan and Singapore but the competition with Indonesia is high.

According to wholesalers in Pampanga, the reject rate is the harvest of a fishpond was estimated at 40%. This figure was hard to obtain from Camarines Norte and Northern Samar.

Consignations agents were paid on a commission basis taking 5% to 7% of the income from the sales of the farm.

- *Wholesale*

Export quality mud crabs from Camarines Norte were transported by bus in native bags. From Northern Samar, crabs were either shipped by boat to Sorsogon and then by bus or shipped direclty to Manila by airplane.

Export quality crabs and those intended for the local market where transported by car to the selling areas.

Wholesale price were lower in Camarines and Northern Samar of around PHP 50/kg than in Pampanga. Male of 500 to 600 g were bought PHP 250/kg in Camarines and Northern Samar, PHP 300/kg in Pampanga.

- *Retail*

In the local retail markets, crabs were categorized by size only. Prices ranged between PHP 180/kg up to PHP 400/kg respectively for XS (6-7 pieces/kg) and M (2 – 3 pieces/kg) sizes.

- *Export*

Mud crab were exported live. In 2007, 1,726 m. t. of live crabs were exported from the Philippines. Assuming that there were mud crabs, 17% of the national production is exported.

Exporters would transport the crabs in styro by airplanes. Transportation cost was estimated at US$1.30 (PHP 58) per kg.

Exporters shipped 300 kg to 1 m. t. daily. The lowest prices were found in september, october, november which were called « ghost months ».

d. External influences

Importing countries of live food fish and crustaceans had import requirements. Taiwan required a health certificate and a commodity clearance. Hong Kong and Singapore required a commodity clearance. Health certificate is issued by exporting country (in this case, BFAR) to attest the health status of the shipment.

IV. DISCUSSION

IV. 1. The limited supply of crab seeds

a. Stock assessment of mud crab

A common perception among the key players of the mud crab sector was that the wild stock of mud crab was decreasing. Empirical evidence were the rising price of crab seeds resulting in a decrease in the size caught from single size (30 mm) to fly size (<5 mm) in the past five years. A buying stations in Northern Samar, where it is believed that the bulk of mud crab supply comes from capture operations, noticed a decrease of more than 70% in the since the 1990s.

Mud crab stock assessment has not been operated at a national level and was seldomly available at a local level (MSU, 1996). It is believed that this type of baseline study could provide information for an appropriate and coordinated management of the wild stock of crabs. Knowledge of the relative abundance of the *Scylla spp.*, of the spawning and recruitment season in the different localities should be done prior to implementation of regulations.

b. Multifactorial causes of stock depletion

The catch of early stages and juveniles for stocking in grow-out ponds has often been identifyed as a cause of stock depletion. Other factors affecting the wild stock of crabs identifyed by the key players were mangrove destruction, the quality of the water, the use of destructive fishing gear for catching the early stages, dynamite fishing in spawning areas and the catch of all sizes and sex including berried females. If stock depletion seems to be obvious, studies on mud crabs population dynamics should be undertaken to clarify the situation.

Hatchery appears to be a miracle solution to the local availability of seeds, the seasonnality of the supply, and the conservation of the wild stock. The existence of hatchery technology for mud crabs and its development in other South East Asian countries are an indication for its potential development. However, in the Philippines, hatchery is not yet an innovation but still a discovery. Mud crab hatchery had not yet been adopted by the private sector and have not proven their resilience.

It should be mentionned however that poor quality of the seedstock, loss of employments in the current supply chain and pollution are possible problems linked to the adoption of hatchery technologies as mentionned for shrimp hatcheries. Milkfish can spawn in captivity and is currently being produced in large commercial quantities by private hatcheries in Taiwan and Indonesia. In the Philippines, only a few commercial milkfish hatcheries supply 10% of the fry requirement (Marte, 2003). It seems that the importance of the brackishwater resources in the Philippines and the good conditions in which the mud crabs are handled and transported allow the supply of juveniles at the present.

Appropriate resource management and regulation of fishing methods seem to be a better option than the development of hatchery technologies at the present.

c. Regulation of the transport of crab seeds

The main existing regulation regarding the supply chain of crab seeds is a ban on the export of juveniles under 75 mm of the provinces supplying seeds located in Bicol Region (Catanduanes) or in the Eastern Visayas (Northern Samar). The rationale and the objectives of such a regulation remains unclear.

The objective could be to decrease fishing pressure on the early stages such as fly size without sanctioning the catchers. The ban would apply to crab seed traders and the control made easier by the existence of check points in the different province. If only the bigger sizes were caught, the catchers as well as the traders would earn more by collecting the bigger sizes. It is however believed that the crab seed traders would not be able to complete orders anymore and that the pressure on the wild stock would not be decreased. In fact, the mortality between fly size and matchboxsize might possibly be higher in the wild than in the collection and transporting process.

The objective could also be to develop nursery technologies and mud crab culture in the provinces supplying seeds. Considering the economics of mud crab nursery in ponds compared to other culture systems, there is really no incentives for farmers to engage in nursery operations. Moreover, the mortality rate in nursery and transport operation is higher than the mortality is direct transport to culturing provinces. There is in fact no economic and environmental reason to develop mud crab nurseries at the present.

d. Appropriate management of the wild stock of mud crabs

If the rationale of the present regulation is arguable, appropriate stock management and fishing regulation is a priority for the sustainability of the mud crab sector.

Possible regulations could prohibit the use of certain fishing gear, establish a closed season and protected areas. Only research and baseline studies could provide information on the period of recruitment season or on the location of major recruitment areas.

Implementation and enforcement of regulations regarding environment conservations can be difficult in such a dynamic and quickly developing country. It is believed that environmentally friendly practices would be adopted if the operators had an economic incentive in doing so.

IV. 2. Comparative resilience of the farming systems involving mud crab

Mud crab are mostly cultured in association with other species in brackishwater ponds. Extensive polyculture has indeed demonstrated its resilience by being adopted by a large number of farmers and operated until now. The resilience of other culture systems involving mud crabs should be assessed considering that institutions are already venturing in the dispersal of those technologies.

a. Pond culture vs Pen culture

Culture in pens is more economic than pond culture with an investment cost estimated at PHP 5,000 for 200m^2, compared to PHP 30,000 for a 150m^2 fishpond. However, lifespan of pens is probably shorter than that of fishponds.

Culture in pens does not require to cut and clear mangrove as opposed to fishpond construction, and is indeed referred as mangrove friendly aquaculture. The main environmental issue of pen culture is its poor resilience to extreme weather such as typhoons. Pond construction is not an option either in those provinces considering the role of mangrove in natural protection.

While culturing in pens, the farmer is granting a permit from the government but does not own the area of the mangrove he is operating. It is believed that the farmer will be a lot less involved in the activity if the perspective are short term.

b. Extensive polyculture vs Monoculture

Profit from monoculture and polyculture is similar. However, the risk associated with the culture system is significantly different. In monoculture, the aquaculturists relies only on one species. In the case of a high mortality of crabs in relation to sudden climate change or typhoon or diseases, the aquaculturist has no back up species to limit his loss. Moreover, the profit from monoculture is limited by the low stocking density in relation to cannibalism. In polyculture, the high mortality or the decrease in prices of one species can always be balanced by another species. Indeed, mud crab is an important back up species considering the low survival of tiger prawn.

Polyculture relies on low feeding rates. The production of the ponds mostly relies on the natural productivity of the water. Monoculture requires a higher amount of feeds (trashfish, molluscs). The sustainability of the use of trashfish and molluscs compared to other artificial feeds should be assessed. Extensive polyculture supposedly relies on low stocking rate as well, however, tiger prawn is stocked at a density of 35,000 pieces/ha and requires indeed high amout of feeds as well. The status of prawns and shrimps in extensive polyculture is questionned. In a changing coastal environment with increasing population and pollution pressure, extensive farming methods run greater risks than intensive farming, since they are more directly linked and dependent on nature's services. Fragile species such as shrimps and prawns run greater risks.

c. Potential for the increase of mud crab production

Mud crab stocking density in polyculture is relatively low (400 – 1,000 pieces/ha) compared to the densities of experimental trials (5,000 pieces/ha). Reasons of the operators for not increasing the densities could be the competition with the prawns or a decrease in prices if the quantity harvested was too high. In both cases, studies should be conducted to examine the technical feasability of an increase in mud crab density and the price structure of mud crabs. None of the operators were considering that the crab seeds were difficult to access.

Production in mud crab fattening is closely related to capture operations. If the stock of mud crabs is well managed, fattening could be more important in producing crabs than polyculture in areas such as Northern Samar.

IV. 3. Satisfaction of the local market and export dynamics

According to some farmers in Pampanga, prices of crabs were decreasing when an important volume of crabs was harvested indicating a possible saturation of the domestic market. According to exporters, there were ghosts months (September to November) where Chinese demand was low. Mud crab market perspectives seem indeed limited.

IV. 4. Sustainability of the mud crab sector

The mud crab sector could be sustainably developped in the three surveyed provinces.

In Northern Samar and Camarines Norte, brackishwater pond area is limited but the mangrove is relatively well preserved. The three main activities in these provinces (juvenile collection, capture and polyculture) should be organized in order to preserve the natural resource as well as the livelihoods of those key players. In the Philippines, FARMCs (Fisheries and Aquatic Resources Management Council) are an advisory body composed of fishermen helping the LGUs in managing aquatic resources. Unfortunately, inland fisheries operators and fish farmers are generally not included in these meetings. The regulation of the collection of mud crabs and of culture becomes urgent in these relatively poor regions so that the key players should be meeting to organize themselves.

In Pampanga, polyculture systems produce thousands of tons of fish and crustaceans in over thousands of hectares of fishponds. The province supplies a city of more than 10 million inhabitants in milkfish and tilapia considered as fish of the poor. Given the poor performance of shrimp in polyculture system, the crab is more important than ever. However, increased production of crab seems difficult given the cannibalistic nature of this species. On the other hand, the domestic market appears saturated while the export market is unstable. Experimental trials must be conducted to verify the technical and economic results obtained in polyculture when crab density is increased. On the other hand, a study should in detail the prospects of market structure.

The crab sector has been in a phase of slow growth for more than ten years. It is essential that institutions stay vigilant regarding the sustainability of this growth.

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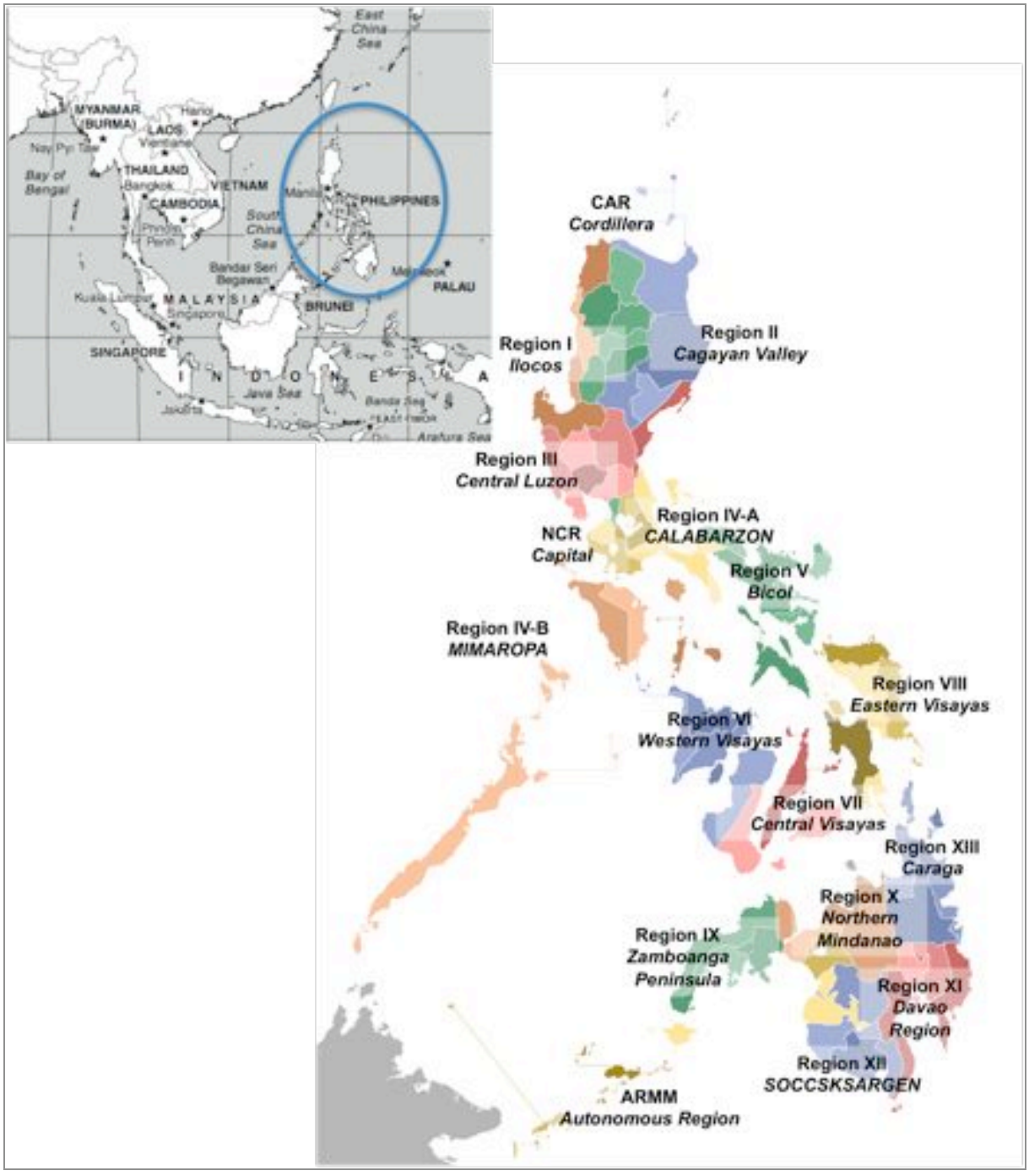
APPENDIXES

Appendix 1.
Administrative map of South East Asia and of the Philippines
Source : http://www.eduplace.com/ss/maps/



Appendix 2.
Physical features of the Philippines

Table 1. Physical data of the Philippines
Source : BAS, 2007, (1) NAMRIA, 1990, (2) 1992 Inventory of brackishwater ponds

Physical feature	Philippines
Land Resources	
1. Number of islands	7,100
2. Total Land Area	2,973,500 ha
3. Length of Coastline	17,460 km
Marine Resources	
1. Total Territorial Water (including EEZ)	220 millions ha
a. Coastal	*26.6 millions ha*
b. Oceanic	*193.4 millions ha*
2. Shelf area (within 200 m depth)	18.4 millions ha
3. Coral Reef Area	2.7 millions ha
Inland water bodies	**749,917 ha**
1. Swamplands	246,063 ha
a. Freshwater	*106,328 ha*
b. Brackishwater (1)	*139,735 ha*
2. Existing Fishponds (wether in use or idle)	253,854 ha
a. Freshwater	*14,531 ha*
b. Brackishwater (2)	*239,323 ha*
3. Other Bodies	250,000 ha
a. Lakes	*200,000 ha*
b. Rivers	*31,000 ha*
c. Reservoirs	*19,000 ha*

Table 2. Mangrove and fishpond area by province in the Philippines. No data was specifically available for brackishwater fish pond area.
Source : NAMRIA, 2003

STATISTICS OF MANGROVE AND FISHPOND
(Based on 2003 Forest/Land Cover Statistics)

PROVINCE	Mangrove Forest* (In Has.)	Fishpond (In Has.)
REGION I		
ILOCOS NORTE	-	-
ILOCOS SUR	-	80
LA UNION	-	1,810
PANGASINAN	160	19,660
Sub-total	**160**	**21,550**
REGION II		
BATANES	-	-
CAGAYAN	7,330	100
ISABELA	1,270	-
NVA. VISCAYA	-	-
QUIRINO	-	-
Sub-total	**8,600**	**100**
REGION III		
AURORA	370	60
BATAAN	-	4,320
BULACAN	-	28,280
NUEVA ECIJA	-	-
PAMPANGA	-	15,120
TARLAC	-	-
ZAMBALES	-	1,200
Sub-total	**370**	**48,980**
NCR	30	2,900
REGION IV-A		
BATANGAS	280	-
CAVITE	300	90
LAGUNA	-	-
QUEZON	10,670	5,760
RIZAL	90	-
Sub-total	**11,340**	**5,850**
REGION IV-B		
MARINDUQUE	2,170	-
OCC. MINDORO	290	4,260
OR. MINDORO	60	2,050
PALAWAN	54,730	1,350
ROMBLON	1,380	30
Sub-total	**58,630**	**7,690**
REGION V		
ALBAY	690	220
CAM. NORTE	5,460	3,360
CAM. SUR	2,340	4,210
CATANDUANES	250	1,110
MASBATE	2,860	4,230
SORSOGON	1,910	2,740
Sub-total	**13,500**	**15,870**
REGION VI		
AKLAN	160	8,150
ANTIQUE	300	250
CAPIZ	930	20,050
GUIMARAS	410	1,030
ILOILO	1,060	14,500
NEGROS OCC.	1,740	14,740
Sub-total	**4,600**	**58,720**

PROVINCE	Mangrove Forest* (In Has.)	Fishpond (In Has.)
REGION VII		
BOHOL	6,470	4,850
CEBU	3,400	1,630
NEGROS OR.	1,780	2,550
SIQUIJOR	110	-
Sub-total	**11,760**	**9,030**
REGION VIII		
BILIRAN	110	-
E. SAMAR	7,330	10
LEYTE	4,690	940
N. SAMAR	10,720	270
S. LEYTE	120	380
SAMAR	16,340	740
Sub-total	**39,310**	**2,340**
REGION IX		
ZAMBOANGA S.	5,420	6,370
ZAMBO CITY	3,940	5,980
ZAMBOANGA N.	680	1,460
SIBUGAY	11,690	10,630
CITY OF ISABELA	610	570
Sub-total	**22,340**	**25,010**
REGION X		
BUKIDNON	-	-
CAMIGUIN	-	-
LANAO DEL N.	720	2,170
MISAMIS OCC.	1,610	1,200
MISAMIS OR.	160	780
Sub-total	**2,490**	**4,150**
REGION XI		
COMP. VALLEY	50	360
DAVAO	50	2,420
DAVAO OR.	1,630	1,280
DAVAO DEL SUR	280	2,630
Sub-total	**2,010**	**6,710**
REGION XII		
N. COTABATO	-	-
SARANGANI	140	1,280
S. COTABATO	-	240
S. KUDARAT	380	570
COTABATO CITY	920	1,170
Sub-total	**1,440**	**3,260**
REGION XIII - CARAGA		
AGUSAN DEL N.	1,340	2,780
AGUSAN DEL S.	-	-
SURIGAO DEL N.	16,820	1,280
SURIGAO DEL S.	8,580	1,770
Sub-total	**26,740**	**5,830**
ARMM		
BASILAN	6,360	860
LANAO DEL S.	150	-
MAGUINDANAO	180	610
SULU	24,700	-
TAWI-TAWI	14,830	-
Sub-total	**46,220**	**1,470**
TOTAL	**249,540**	**219,460**

Data Source : Landsat Enhanced Thematic Mapper 2002-2003
* Includes partial Mangrove Plantation; subject to ground validation

Appendix 3.
Socio economic indicators of the Philippines

Table 1. Selected economic indicators
Source : NSCB, 2007 ; Yap, 1999

Economic accounts	2007	1997
GDP (at current prices)	PHP 6,647,338 million	-
GDP (at 1985 constant prices)	PHP 1,336,493 million	PHP 893 ,017 million
GNP (at current prices)	PHP 7,227,312 million	PHP 2,526,891 million
GNP (at 1985 constant prices)	PHP 1,495,589 million	PHP 931,118 million
GVA (at 1985 constant prices)		
Agriculture	PHP 249,989 million (18.3%)	PHP 184,713 million (20.7%)
Industry	PHP 443,067 million (32.5%)	PHP 320,689 million (35.9%)
Services	PHP 672,115 million (49.2%)	PHP 387,615 million (43.4%)

Table 2. Contribution of fisheries to GVA in agriculture, fishery and forestry
Source : NSCB, 2007 ; Yap, 1999

	At current prices Amount in million PHP (% of GVA in agri sector)		At 1985 constant prices Amount in million PHP (% of GVA in agri sector)	
	2007	**1997**	**2007**	**1997**
Agricultural crops (palay, corn, coconut)	562,390 (59.9%)	263,560 (58.2%)	124,856 (49.9%)	99,973 (54.1%)
Livestock	116,892 (12.4%)	61,368 (13.6%)	29,083 (11.6%)	22,273 (12.1%)
Poultry	68,650 (7.3%)	36,194 (8.0%)	25,069 (10.0%)	19,088 (10.3%)
Agricultural activities and services	43,626 (4.6%)	20,907 (4.6%)	11,075 (4.4%)	7,992 (4.3%)
Fisheries	143,426 (15.3%)	67,776 (15.0%)	58,584 (23.4%)	34,275 (18.5%)
Forestry	4,133 (0.4%)	2,741 (0.6%)	1,322 (0.5%)	1,112 (0.6%)
TOTAL	939,117 (100.0%)	452,546 (100.0%)	249,989 (100.0%)	184,713 (100.0%)

Table 3. Income statistics
Source : NSCB, 2007 ; Yap, 1999

Income statistics	2007	1997
Average annual income	PHP 172,130	PHP 123,881
Average annual expenditure	PHP 147,180	PHP 100,194
Poverty threshold (Annual per capita)	PHP 15,057	PHP 11,388
Poverty incidence of total families	26.9%	32.1%
Food (subsitence) threshold (Annual per capita)	PHP 10,025	PHP 7,724
Subsistence incidence of total families	11.0%	16.5%

Table 4. Trade
Source : BFAR, 2007 ; Yap, 1999

Trade	2007		1997	
Total trade	US$ 105,980.0 million		US$ 61,161.52 million	
Exports	US$ 50,466.0 million		US$ 25,227.70 million	
Imports	US$ 55,514.0 million		US$ 35,933.82 million	
Balance (deficit)	(US$ 5,048.0 million)		(US$ 10,706.12 million)	
Agricultural exports	US$ 3,170 million f. o. b		-	
% of agricultural in total exports	6.3%		-	
Agricultural imports	US$ 4,920 million c. i. f		-	
% of agricultural in total imports	8.5%		-	
Balance (deficit)	US$ 1,750 million		-	
	Quantity	**FOB Value**	**Quantity**	**FOB Value**
Fisheries exports	173,076 T	US$ 570 million	173,887 T	US$ 549.8 million
Fisheries imports	204,458 T	US$ 154 million	295,015 T	US$ 138.1 million
Balance (surplus)	(31,382 T)	US$ 416 million	(121,129 T)	US$ 411.7 million

Table 5. Employment
Source : BFAR, 2007 ; Yap, 1999

Employment	2007	1997
Labor participation rate	64.8%	65.4%
Employment rate	92.2%	92.3%
Unemployment rate	7.8%	7.7%
Employed persons	33.56 million	-
Agriculture, hunting and forestry	11.76 million (35%)	-
Industry	4.98 million	-
Services	19,930 million	-
Employed persons	1,614,368	990,872
Municipal fisheries	1,371,676	675,677
Commercial fisheries	16,497	56,715
Aquaculture	226,195	258,480

Appendix 4.
Fisheries statistics in the Philippines

Table 1. Aquaculture and capture production by species in quantity and value in 2007
Source : BAS, 2007

	Aquaculture		Inland municipal fisheries	
Species	**Volume (T)**	**Value ('000 PHP)**	**Volume (T)**	**Value ('000 PHP)**
Milkfish	349,740.72	22,320,382.46	2,260.79	154,734.41
Tiger prawn	39,825.27	14,935,011.30	102.79	39,731.12
Mud crab	9,308.54	2,301,893.23	719.19	107,278.04
White shrimp	2,114.77	279,296.11	600.96	62,091.98
Tilapia	241,182.76	13,730,608.70	37,648.51	1,789,313.29
Grouper	417.16	270,957.05	19,035.77	1,795,260.15
Siganid	225.55	34,101.51	31,866.33	1,898,800.09
Carp	19,961.70	350,900.43	10,810.51	474,586.97
Catfish	2,655.12	178,487.91	4,607.26	281,190.44
Oyster	20,508.05	142,011.35	-	-
Mussel	20,113.61	140,682.31	-	-
Seaweeds	1,505,069.58	6,299,346.96	-	-

Table 2. Aquaculture production (in m. t.) by species and main production systems
Source : BAS, 2007

Species	Pond		Pen			Cage			Mariculture	Total production	% of total production
	Brackish	Fresh	Brackish	Fresh	Marine	Brackish	Fresh	Marine			
Milkfish (*Chanos chanos*)	220,567.10	36.72	5,241.86	26,998.08	18,417.92	3,302.17	14,248.01	61,189.50	-	**350,001.36**	**15,80**
Nile tilapia (*Oreochromis niloticus*)	-	130,456.23	-	19,215.22	-	-	79,000.75	-	-	**228,672.20**	**10,32**
Mozambique tilapia (*Oreochromis mossambicus*)	12,155.51	-	80.74	-	-	185.82	-	12.67	-	**12,434.74**	**0,56**
Tiger prawn (*Penaeus monodon*)	39,825.12	-	-	-	0.15	-	-	-	-	**39,825.27**	**1,80**
Bighead carp (*Aristichtys nobilis*) and Common carp (*Cyrpinus carpio*)	-	573.02	-	17,460.96	-	-	1,925.50	-	-	**19,959.48**	**0,90**
White shrimp and Endeavour prawn (*Metapenaeus endeavori*)	2,830.06	-	-	-	-	-	-	-	-	**2,830.06**	**0,13**
Mud crab (*Scylla sp.*)	**9,267.16**	**-**	**-**	**-**	**34.52**	**-**	**-**	**-**	**-**	**9,301.68**	**0,42**
Grouper (*Epinephelus sp.*)	75.93	-	0.02	-	103.09	9.05	-	229.07	-	**417.16**	**0,02**
Siganids (*Siganus sp.*)	82.64	-	1.34	-	35.08	58.83	-	47.66	-	**225.55**	**0,01**
Catfish	-	2,649.10	-	0.03	-	3.35	-	-	-	**2,652.48**	**0,12**
Oysters	-	-	-	-	-	-	-	-	20,508.05	**20,508.05**	**0,93**
Mussels (*Perna viridis*)	-	-							20,113.61	**20,113.61**	**0,91**
Seaweeds (*Kappaphycus and Euchema sp.*)	-	-							1,505,069.58	**1,505,069.58**	**67,96**
Total	**285,593.89**	**135,186.99**	**5,337.61**	**63,674.29**	**18,417.92**	**3,563.49**	**95,177.61**	**62,096.93**	**1,545,691.24**	**2214739,97**	**100**

Table 3. Major fishery exports in terms of value
Source : BFAR, 2007

Commodity/kind	Quantity (m. t.)	FOB value (US$)	(PHP)
1. Tuna	**75,148,345**	**218,628,885**	**10,067,860,154**
Fresh/chilled/frozen	26,863,742	93,646,986	4,312,443,705
Smoked/dried	403	1,410	64,931
Canned	48,284,200	124,980,489	5,755,351,518
2. Seaweeds	**26,203,757**	**91,850,596**	**4,299,719,946**
Seaweeds and other algae, nes.	10,486,216	19,697,970	907,091,519
Seaweeds for human consumption	1,568,539	2,133,238	98,235,610
Carageenan	14,149,002	10,019,388	3,224,392,817
3. Shrimp/Prawn	**10,760,235**	**86,500,233**	**3,983,335,730**
Fresh/chilled frozen	10,063,753	84,516,030	3,891,963,182
Breeder	188	750	34,538
Dried	48,451	334,622	15,409,343
Prepared and preserved	647,843	1,648,831	75,928,668
4. Crabs/crabs fat	**3,990,133**	**40,754,448**	**1,876,742,330**
Live, frozen	1,809,996	8,994,576	414,200,225
Prepared/preserved	2,180,137	31,759,872	1,462,542,106
5. Octopus	**6,909,544**	**20,597,210**	**948,501,521**
Dried, salted or in brine	64,647	179,873	8,283,152
Fresh or chilled	117,123	241,022	11,099,063
Frozen	6,727,774	20,176,315	929,119,306
6. Sardines	**9,169,813**	**16,993,602**	**782,555,372**
Fresh/chilled/frozen	206,025	245,918	11,324,524
Smoked	3,013	13,203	607,998
Prepared/preserved	8,960,775	16,734,481	770,622,850
7. Grouper			
Grouper for breeding, live	5,358,388	16,586,777	763,821,081
8. Cuttlefish/squid	**3,237,326**	**12,251,274**	**564,171,168**
Fresh/chilled/frozen/dried	2,987,550	11,641,839	536,106,686
Prepared/preserved	249,776	609,435	28,064,482
9. Lobster			
Fresh or chilled	1,803,974	9,223,731	424,752,813
10. Milkfish	**2,518,035**	**9,223,731**	**424,752,813**
Live, fresh, chilled, frozen	1,545,615	4,739,791	218,267,376
Dried, wtr/not salted	132,915	403,946	18,601,713
In airtight containers	839,505	2,557,417	117,769,053
Total major commodities	**145,099,550**	**521,087,910**	**23,996,098,526**
Total of other commodities	**27,976,130**	**48,700,982**	**2,242,680,221**
Grand Total	**173,075,680**	**569,788,892**	**26,238,778,477**

Table 4. FAO production figures (tonnes) for Indo-Pacific swamp crab or mud crab capture
Source : FAO, FishStat at http://www.fao.org/fishery/statistics/global-capture-production/query/fr

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Fiji Islands	234	208	290	270	281	250	268	180	82	324	370	427	339
French Polynesia	0	0	2	2	2	2	2	3	3	3	3	6	6
Indonesia	7,980	7,342	8,298	8,161	8,707	8,774	11,753	11,240	14,802	20,129	19,098	23,456	25,641
Mauritius	22	23	19	23	21	25	24	22	24	21	20	2	3
Micronesia	5	5	5	5	5	5	5	5	5	5	5	5	5
Palau	1	1	1	2	8	6	8	6	4	4	3	4	12
Papua New Guinea	28	25	24	23	22	5	4	9	15	6	9	14	10
Phlippines	4,835	4,258	1,133	1,124	1,211	1,247	1,604	1,458	1,663	1,466	1,432	1,502	1,803
Singapore	27	19	15	9	9	28	9	8	11	14	28	36	23
Taiwan	1,339	935	180	215	269	299	230	337	375	9	717	521	647
Thailand	5,776	4,243	4,031	3,732	5,736	6,921	5,417	3,823	1,259	2,859	1,744	7,018	3,346
Total	13,065	17,059	13,998	13,566	16,271	17,562	19,324	6,975	18,243	24,840	23,429	32,991	31,835

Table 5. FAO production figures (tonnes) for Indo-Pacific swamp crab or mud crab aquaculture
Source : FAO, FishStat at http://www.fao.org/fishery/statistics/global-aquaculture-production/query/fr; (1) BFAR, Fisheries Profile

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Australia	0	0	44	44	0	0	0	0	0	0	0	0	0
Brunei Darussalam	0	0	0	0	0	0	0	0	0	1	0	3	3
Cambodia	0	0	0	0	0	0	0	0	0	0	0	0	0
Indonesia	1,906	1,339	5,176	866	5,143	5,126	3,879	9,039	7,152	2,243	4,379	5,516	6,631
Malaysia	623	381	277	231	188	225	219	311	204	174	162	141	86
Mauritius	5	4	2	4	3	1	2	1	2	2	2	2	1
Myanmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Philippines	2,782	2,463	3,759	4,033	4,826	4,968	4,608	4,747	4,809	6,245	6,861	7,800	9,308
Philippine[(1)]	2,782	2,440	3,710	4,026	4,215	4,495	4,608	4,726	4,785	6,244.9	6,836.5	7,782.2	9,267.2
Singapore	342	353	215	45	78	86	75	93	104	60	37	81	47
Sri Lanka	0	0	0	0	0	0	0	1	2	1	2	1	1
Taiwan	1,526	797	430	796	381	315	423	239	226	239	240	247	221
Tanzania	0	0	0	0	0	0	0	0	0	0	0	1	1
Thailand	45	132	115	19	9	9	5	10	10	23	15	15	11
Total	7,229	5,649	10,018	6,038	10,628	10,730	9,211	14,441	12,509	9,988	11,698	13,804	16,309
China	-	-	-	-	-	-	-	-	88,306	94,935	97,643	93,363	101,529

Appendix 5.
Presentation of the studied areas

Table 1. Socio economic profile of the studied areas
Source : NCSB, 2006 :BAS, 2008

PROVINCE	Camarines Norte	Northern Samar	Pampanga	Philippines
Population (NSO, 2007)	513,785	549,759	1,911,951	88.57 million
Area	232,007 ha	369,293 ha	206,247 ha	
Density				
Number of cities, municipalities and barangays	12 municipalities – 282 barangays	24 municipalities – 569 barangays	2 cities – 20 municipalities – 538 barangays	
Poverty Incidence Among the Population (%) (NSCB, 2006)	49.3%	61.1%	10.8%	32.9%
Major Upland Crops Production (BAS, 2008)	**Coconut :** 214,207 m. t. **Pineapple :** 112,241 m. t. **Banana :** 7,744 m. t.	**Coconut :** 301,090 m. t. **Sweet potatoe :** 20,669 m. t. **Banana :** 12,908 m. t. **Abaca :** 4,870 m. t.	**Sugarcane :** 347,930 m. t. **Banana :** 2,682 m. t.	**Sugarcane :** 26,601,384 mt **Coconut :** 15,319,527 mt **Banana :** 8,687,624 mt **Pineapple :** 2,209,336 mt
Major Upland Crops Area harvested (BAS, 2008)	**Coconut:** 85,370 ha **Pineaple :** 2,731 ha **Banana:** 4,503 ha	**Coconut :** 77,925 ha **Sweet potatoe :** 7,543 ha **Banana :** 5,632 ha **Abaca :** 11,624 ha	**Sugarcane :** 7,320 ha **Banana :** 492 ha	**Coconut :** 3,359,776.5 ha **Banana :** 436,261.8 ha **Sugarcane :** 382,956.4 ha
Rice production (BAS, 2008)	64,082 mt	76,766 m. t.	390,290 m. t.	16,240,194 m. t.
Rice area harvested (BAS, 2008)	20,814 ha	39,840 ha	85,910 ha	4,459,977 ha
Livestock Inventory (BAS, 2008)				
▪ Carabao	59,091.00	95,119.00	34,023.00	3,338,570
▪ Cattle	12,112.00	2,573.00	14,780.00	2,566,492
▪ Goat	13,197.00	25,614.00	17,302.00	4,174,251
▪ Hog	362,460.00	568,020.00	589,590.00	13,701,020
▪ Chicken	1,620,705.00	2,696,433.00	28,242,789.00	154,272,036
▪ Duck	83,938.00	67,876.00	2,087,124.00	10,508,205

Table 2. Fisheries production in the studied areas
Source : BAS, 2008

PROVINCE	Camarines Norte	Northern Samar	Pampanga	Philippines
Volume of fisheries production (m. t.)				
▪ Aquaculture	27,889 (51%)	559 (3%)	131,144 (92%)	2,214,826 (47%)
▪ Inland fisheries	119 (<1%)	639 (4%)	9,889 (7%)	168,277.28 (4%)
▪ Marine municipal fisheries	22,079 (40%)	12,934 (77%)	2,078 (1%)	1,136,079.19 (24%)
▪ Commercial fisheries	4,514 (8%)	2,621 (16%)	-	1,192,069.78 (25%)
Value of fisheries(PHP)				
▪ Aquaculture	219,506 (14%)	66,362 (7%)	**14,405,712 (96%)**	61,597,274 (34%)
▪ Inland fisheries	8,866 (1%)	40,719 (4%)	574,504.92 (4%)	5,790,183.69 (3%)
▪ Marine municipal fisheries	**1,160,046 (74%)**	**701,065 (74%)**	159,293 (1%)	58,420,202.04 (32%)
▪ Commercial fisheries	177,228 (11%)	143,022 (15%)	-	54,737,468.34 (30%)

Appendix 6.
Questionnaires

N° Interview : T1	TRADER
Location	
Date	
Present persons	
Main interlocutor	
Contact	
PROFILE	
Name of household head	
Age	
Educational attainment	
Household size	
Type of business	
Activities	
History	

TECHNIQUE	DESCRIPTION	COMPTABILITY
Stocking area		
Stocking gear		
Stocking inputs		
Stocking duration		
Repacking		
Redistributing in lots		
Transportation		
Labor		

TRADING SPECIES	SIZE	COST PRICE	SALE PRICE	QUANTITY	MORTALITY		REGULARITY	OTHER
					transport	stocking		

MARKET	CRAB SEEDS	MARKETABLE SIZE
Key supplier		
Geographical origin		
Key Customer		
Regularity of demand		
Species requirement		
Size requirement		
Packing requirement		
Setting prices		
Payment scheme		
Price evolution		
Competition w/traders		

SUPPOSED GEOGRAPHICAL FLOW OF PRODUCT

EXTERNAL INFLUENCE	
State intervention	
Organisation	

OTHER

N° Interview : FP 1	FISHPOND OPERATOR
Location	
Date	
Present persons	
Main interlocutor	
Contact	
PROFILE	
Name of household head	
Age	
Educational attainment	
Household size	
Type of business	
Activities	
History	
LAND	
Pond size	
Land type before pond	
Tenure type (*specify owner if not owned*)	
Arrangement (*if not owned*)	
Acquisition type	
Acquisition time	

TECHNIQUE

GROWING

Species	Stocking density	Stocking size	Regularity of supply	Size at harvest	N° of harvest	Mortality rate at harvest	Harvest method

Feed type	Feed quantity	Feed frequence

Labour	Pond preparation	Dyke maintenance	Water circulation maintenance

COMPTABILITY

Input	Cost	Output	Income

FLOW OF PRODUCT	CRABLETS	MARKETABLE CRABS
Key supplier		
Geographical origin		
Key Customer		
Geographical origin		
Geographical flow of product		
Species requirement		
Size requirement		
Setting prices		
Payment scheme		
Regularity of demand		

EXTERNAL INFLUENCE	
State intervention	
Organisation	
Other	

OTHER

N° Interview : C 1	CAPTURE OPERATIONS
Location	
Date	
Present persons	
Main interlocutor	
Contact	
PROFILE	
Name of household head	
Age	
Educational attainment	
Household size	
Type of business	
Activities	
History	

TECHNIQUE

FISHING

Species	Fishing gear	Number of fishing gears	Average daily harvest	Activity schedule

COMPTABILITY

Input		Income	

FLOW OF PRODUCT

Key Customer	
Geographical origin	
Geographical flow of product	
Species requirement	
Size requirement	
Setting prices	
Payment scheme	
EXTERNAL INFLUENCE	
State intervention	
Organisation	
Other	
OTHER	

N° Interview : NGA, LGU	INSTITUTIONAL ACTOR (*Specify institution*)
Location	
Date	
Present persons	
Main interlocutor	
Contact	
LAND	
Title deed	
Land acquisition	
TECHNICAL ADVICE	
Technical advice	
Demo farm	
Technical report	
FINANCIAL SUPPORT	
Access to credit	
MARKET	
Collection of products	
Transport of products	
Processing products	
Marketing of products	
Price regulation	
Taxes	
ORGANIZATION	
Organizing fisherfolks	
Number of organizations	
ENVIRONMENT	
Stock assessment	
Regulation of fishing pressure	
Mangrove conservation and rehabilitation	
OTHER	

N° Interview : NGO	INSTITUTIONAL ACTOR (*Specify)*			
Location				
Date				
Present persons				
Main interlocutor				
Contact				
PROFILE				
Age				
Educational attainment				
HiSTORY				
Date				
Founding group				
Story				
ACTIONS				
Field of work				
Comitment				
On going projects				
Location				
Beneficiaries				
Collaborators				
Source of funds				
OTHER				

Appendix 7.
***Biology and ecology of* Scylla spp.**

Table 1. Development stage of the mud crab Scylla sp.
Source : Rodriguez & al., 2001 ; Catacunan, 2002 ; Quinitio & al, 2001

Development stage	**Larval stages**	**Zoeal stages**	**Megalopa (M)**	**First crab stage (C0)**	**First molt (C1)**	**Second molt (C2)**	**Third molt (C3)**
Carapace Width	-	-	-	3 mm	5 mm	6-7 mm	-
Body Weight			4-5 mg				
Duration of intermolt	-	-	16-18 days after hatching	8-10 days	19-26 days	35-54 days	50-61 days

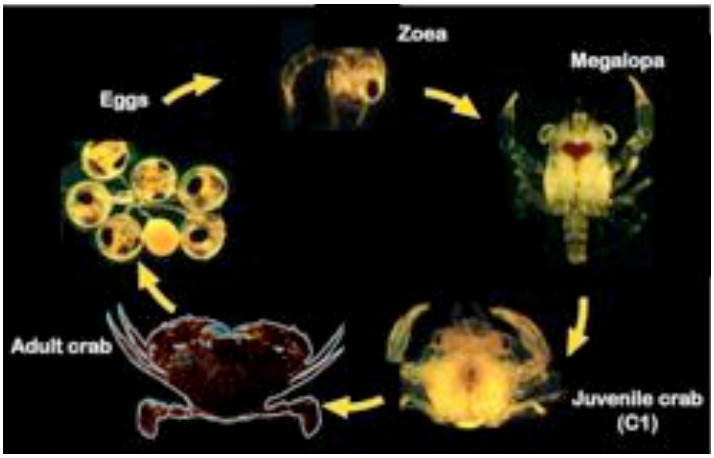


Figure 1. Life cycle of the mud crab

Table 2. Biological characteristics of the mud crab Scylla sp. in different localities
Source : in Le Vay, 2001

Area	Species	Size at maturity	Seasonnality in maturation	Seasonnality in recruitment	Source
Papua New Guinea	Not known	100-120 mm	Peak in April-June and September-October		Quinn & Kojis (1987)
India	Not known	85-129 mm	Year round, peaks in April-June and September-February	Peak availability of juveniles in December to October, throughout the year in some areas	Angell (1992)
India (Pichavaram)	Not known	-	-	Juveniles (2-3cm) abset during low salinity period in monsoon dry season (January-February)	Chandrasekran & Natajaran (1994)
Sri Lanka	Not known	120 mm			Jayamanne (1992)
Thailand (Andaman Sea)	Not known	110 mm	Year round, peak in maturiry October-December	Year round recruitment, based on size-frequency distribution	Poovachiranon (1993)
Thailand (Ranong)	Not known	Majority at 100-115 mm	Peak in maturity in September, main egg carrying and spawning period from July – December		Macintosh & al. (1993)
Thailand (Ranong)	*S. olivacea & paramamosain*	86 mm	Peak in August-October. Spawning season in November-December		Tongdee & al., 2001
South Africa (Natal)	*S. serrata*	123 mm for female (50% mature) 92 mm for males (50% mature)	Spawning throughout the year, with a peak through the summer months	Year round, with peak in juvenile number in May - December	Robertson & Kruger (1994)
South Africa	*S. serrata*	-	-	Year round megalopa in plankton	Forbes & Hay (1988)
South Africa	*S. serrata*	83-144 mm with age of 1 to 1.5 years			Hill (1975)
Australia	*S. serrata*	128 mm for females 165 mm for males	Peak mating activity in spring and early autumn ; spawning only in summer (water temperature>22°C)		Heasman & al. (1985)
Vietnam		Female maturity molt circa 80 mm			Vu Ngoc Ut & al. (1998)
Vietnam (Mekong Delta)	*S. paramamosain*	-	Year round, September-October peak in mature females	Year round recruitment into estuarine mangrove measured as CPUE for juvénile and from size-frequency distribution	Le Vay & al. (2001)
Indonesia North Java	*S. paramamosain*	Female maturity molt : 80-90mm			Le Vay pers. obs.
Philippines	Not known	-	Year round, peaks in May-October		Estampador (1949)

Appendix 8.
Mud crab seed stock supply chain

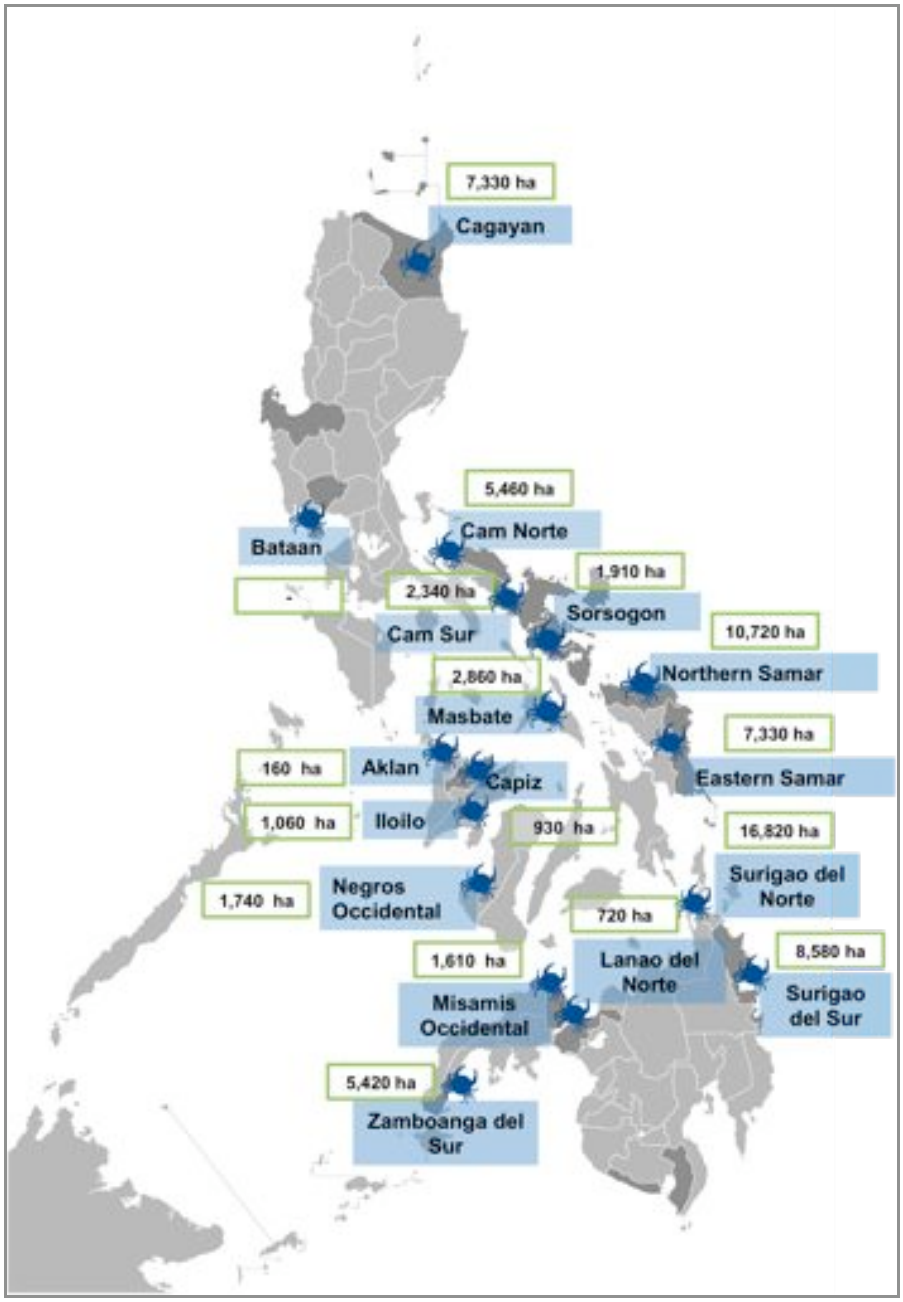


Figure 1. Geographical distribution of the provinces supplying crab seeds in the Philippines. The mangrove area in each province is specified in the green frames.

Table 1. Technology and economics of mud crab hatchery and nursery

Source : SEAFDEC, 2010

Hatchery : technology		
Method	**rented hatchery**	**hatchery using canvas tanks**
Broodstock	12	
BW Broodstock	600 g	
Average zoeae produced per female	1,200,000	
Larval tank capacity	80 tons	
Stocking density of larvae	80/liter	
Number of zoeae needed	6,400,000	
Survival from zoea to megalopa	3%	

Hatchery : costs and return		
Method	rented hatchery	hatchery using canvas tanks
Capital assets	**260,000**	**1,150,000**
Operating Cost	**142,261**	**176,769**
▪ *Variable cost*	*58,394*	*58,394*
Broodstock, feeds, chemicals	37,853	37,853
Electricity (kwh)	12,000	12,000
Marketing *(2% of revenue)*	5,760	5,760
Misc *(5% variable cost excluding labour)*	2,781	2,781
▪ *Fixed cost*	*83,867*	*118,375*
Labor	36,000	36,000
Repairs and maintenance *(5% fixed assets)*	13,000	11,458
Rent	15,000	-
Rent on land	-	3,000
Interest on capital	5,200	23,000
Depreciation	14,667	44,917

Costs and return		
Total harvest crab	96,000	96,000
Total revenue crab *(3 P/unit)*	288,000	288,000
Net income/run	145,739	111,232
ROI	78.53%	58.03%
Variable cost/unit	0.61	0.61
Breakeven price	1.48	1.84
Breakeven quantity	47,420	58,923
Net benefit		

Table 2. Technology and economics of nursery production
Source : SEAFDEC, 2010 ; Muhia & Lutao, 2007 ; Rodriguez

	Nursery			
Method	concrete tanks	pens	net cages in ponds	nursery ponds
Location	SEAFDEC AQD	Northern Samar	SEAFDEC AQD	Northern Samar
Reference	SEAFDEC internet	Muhia & Lutao, 2007	Rodriguez & al., 2001	(survey Northern Samar[1])
Area/Capacity	10-ton tanks	500 m^2	20 m^2 net in 0.1 ha pond	0.8 ha
Size of seeds	megalops	fly size (10 mg)	megalops (4-6.4 mg)	fly size (10 mg)
Stocking density	1-2 /liter	25/m^2	30 /m^2	9/m^2
Fertilizer	-	-	Agricultural lime – 1 ton/ha Chicken manure – 1 ton/ha	Urea-40 kg/ha 16-20-0 – 50 kg/ha Chicken manure
Food items	*Artemia*, minced trashfish, small shrimps and mussels	trashfish	Brown mussel meat, fish	trashfish
Feeding rate	-	5% (20 kgs)	30% first week, 20% then (3 kgs)	5% (est.) (50 kgs est.)
Number of days	30 days	20-30 days	30 days	2-3 months
BW at harvest	3 g	10 g	3 g	30-40 g
Survival rate	50%	50%	50%	30%

[1]An NGO in Northern Samar had been stocking megalopa directly in a 0.8 ha pond for nursery purposes and dispersal to farmers. It seems that these operators had been misinformed regarding nursery technologies.

		Nursery		
Method	unit cost	pens	cages in ponds	nursery ponds
Reference	-			
Area	-	500m^2	20m^2	1 ha
Investment requirement	-	PHP 6,570	PHP 1,392	PHP 30,329
bamboo poles	PHP 50/pole	PHP 2,500 (50 poles)	PHP 400 (8 poles)	PHP 7,500 (150 poles)
green nylon net	PHP 18/m	-	-	PHP 7,236 (402 m)
fine mesh nylon screen	PHP16 /m	PHP 1,424 (89 m)	PHP 288 (18 m)	PHP 1,210 (448 m)
polyethylene rope	PHP 23/roll ?	PHP 23	PHP 23	PHP 320 (14 rolls)
nylon monofilament	PHP 120/kg	PHP 120	PHP 120	PHP 2,040 (17 kgs)
nails	PHP 4/piece	-	-	PHP 160 (40 pieces)
plastic sheet (rolls)	PHP 4,000/roll	PHP 500	PHP 100	PHP 4,000
labor for cage construction	-	PHP 300	PHP 100	-
labor for enclosure construction (35% of total cost of material)	-	PHP 1,703	PHP 361	PHP 7,863
Operational costs	-	PHP 23,300	PHP 4,020	PHP 131,800
cost of seeds	PHP 1.50/piece	PHP 18,750	PHP 900	PHP 120,000
cost of feeds	PHP 20/kg	PHP 300	PHP 60	PHP1,000
labour	PHP 3,000/month	PHP 3,000	PHP 3,000	PHP 6,000
marketing expenses (2% of sales)	-	PHP 1,250	PHP 60	PHP 4,800
Selling price	PHP 10.00 /piece	PHP 62,500	PHP 3,000	PHP 240,000
Costs & returns		PHP 39,200	PHP 1,020	PHP 108,200
Net Margin		PHP 3.16/piece	PHP 1.7/piece	PHP 1.35/piece

Table 3. Costs & returns of crab seed trading
Source : survey

- *Collecting from the catchers and storing*

The mortality rate while storing is estimated at 10% for fly size and 5% for single size. Mortality during transport and packing are on the exporter's expenses. Transport costs are at the charge of the collector.

The costs for storing *fly size* are :

1,000 pieces of fly size purchased at PHP 1.50/piece = PHP 1,500
900 pieces packed and transported = PHP 50

Total costs = PHP 1,550
Sales revenue of PHP 2.00/piece x 900 pieces = PHP 1,800
Thus the margin of the trader = PHP 250 or **PHP 0.25/piece**

The costs of storing *single size* are :

500 pieces of single size purchased at PHP 7.00/piece = PHP 3,500
475 pieces packed and transported = PHP 50

Total costs = PHP 3,550
Sales revenue of PHP 9.00/piece x 475 pieces = PHP 4,275
Thus the margin of the trader = PHP 775 or **PHP 1.55/piece**

- *Transport of crab seeds outside the provinces*

Packing material for fly size costs PHP 25 for 1,000 pieces. For single size, 500 pieces can be packed in a PHP 25 box. Average transportation fee is estimated at PHP 200 for 5,000 pieces of fly size, PHP 200 for 1,000 pieces of fly size. The mortality rate during transport is on the exporter's expenses. Mortality rate during transport is estimated at 5% for fly size and 1% for single size.

The costs of transporting *fly size* are :

5,000 pieces of fly size purchased at PHP 2.00 = PHP 10,000
5,000 pieces packed and transported = (25 x 5) + 200 = PHP 325

Total costs = PHP 10,325
Sales revenue of PHP 3.00/piece x 4,750 pieces = PHP 14,250
Thus the margin of the trader = PHP 4,425 or **PHP 0.88/piece**

The costs of transporting *single size* are :

5,000 pieces of single size purchased at PHP 9.00/piece = PHP 45,000
5,000 pieces packed and transported = (25 x 10) + (200 x 5) = PHP 1,250

Total costs = PHP 46,250
Sales revenue of PHP 11.00/piece x 4,950 = PHP 54,450
Thus the margin of the trader = PHP 8,200 or **PHP 1.64/piece**

Appendix 9.

Mud crab culture in the Philippines

Table 1. Mud crab production in volume (MT) and value ('000) in brackishwater ponds by region and province in the Philippines
Source : BAS, 2008

MUD CRAB					
	Volume (m. t.)	Value ('000 PHP)		Volume (m. t.)	Value ('000 PHP)
Brackishwater ponds	**9,267.16**	**2,292,703.95**			
1. Ilocos Region	**24.41**	**4,114.80**	**9. Central Visayas**	**4.35**	**1,120.00**
Ilocos Norte	*0.20*	*30.00*	*Bohol*	*4.00*	*1,015.00*
Ilocos Sur	-	-	*Cebu*	*0.35*	*105.00*
La Union	*0.10*	*25.00*	*Negros Occidental*	-	-
Pangasinan	*24.11*	*4,059.80*	*Siquijor*	-	-
2. Cagayan valley	**96.18**	**20,158.50**	**10. Eastern Visayas**	**267.48**	**51,992.11**
Cagayan	*96.18*	*20,158.50*	*Biliran*	*0.79*	*158.00*
3. Central Luzon	**3,390.92**	**787,135.16**	*Eastern Samar*	*108.97*	*16,541.40*
Aurora	**-**	**-**	*Leyte*	*1.50*	*150.00*
Bataan	*121.99*	*14,600.82*	*Northern Samar*	*94.18*	*18,528.15*
Bulacan	*58.41*	*20,012.10*	*Southern Leyte*	**-**	**-**
Pampanga	*3,210.47*	*752,514.86*	*Samar*	*62.04*	*16,614.56*
Zambales	*0.05*	*7.38*	**11. Zamboanga Peninsula**	**115.70**	**21,862.41**
4. NCR	**1.41**	**282.00**	*Zamboanga Sibugay*	*39.18*	*7,987.80*
Metro Manila	*1.41*	*282.00*	*Zamboanga City*	*24.33*	*3,140.97*
5. Calabarzon	**50.29**	**8,207.63**	*Zamboanga del Norte*	*5.39*	*889.59*
Cavite	*0.35*	*86.75*	*Zamboanga del Sur*	*46.80*	*9,844.05*
Batangas	-	-	**12. Northern Mindanao**	**3,397.45**	**967,637.74**
Quezon	*49.94*	*8,120.88*	*Lanao del Norte*	*2,945.83*	*880,925.24*
6. Mimaropa	**1.70**	**96.00**	*Misamis Occidental*	*451.62*	*86,712.50*
Mindoro Occidental	-	**-**	*Misamis Oriental*	-	-
Mindoro Oriental	-	**-**	**13. Davao Region**	**6.26**	**1,122.20**
Marinduque	-	**-**	*Compostela Valley*	0.17	*19.50*
Romblon	-	**-**	*Davao City*	-	-
Palawan	*1.70*	*96.00*	*Davao del Norte*	5.87	*1,080.70*
7. Bicol Region	**1,551.36**	**345,034.29**	*Davao Oriental*	0.22	*22.00*
Albay	*12.85*	*1,413.50*	*Davao del Sur*	-	-
Camarines Norte	*123.00*	*16,851.13*	**14. SOCCSKSARGEN**	**0.8**	**69.60**
Camarines Sur	*173.79*	*44,799.16*	*South Cotabato*	-	-
Catanduanes	*4.79*	*1,083.90*	*Sarangani*	*0.8*	*69.60*
Masbate	*51.45*	*14,317.01*	*Sultan Kudarat*	-	-
Sorsogon	*1,185.48*	*266,569.59*	**15. Caraga**	**151.68**	**25,717.68**
8. Western Visayas	**195.81**	**55,169.22**	*Agusan del Norte*	*13.03*	*1,935.56*
Aklan	*6.87*	*1,244.87*	*Surigao del Norte*	*27.39*	*6,898.10*
Antique	*7.38*	*1,080.47*	*Surigao del Sur*	*111.26*	*16,884.02*
Capiz	*163.35*	*49,094.73*	**16. ARMM**	**12.11**	**2,984.61**
Iloilo	*7.25*	*1,991.25*	*Basilan*	-	-
Negros Occidental	*3.96*	*711.90*	*Lanao del Sur*	-	-
Guimaras	*7.00*	*1,046.00*	*Maguindanao*	*12.11*	*2,984.61*
Marine fishcage	**6.86**	**628.85**			
1. Ilocos Region	**-**	**0.80**			
Ilocos Norte	-	*0.80*			
2. Eastern Visayas	**6.50**	**487.50**			
Eastern Samar	*6.50*	*487.50*			
3. Northern Mindanao	**0.36**	**140.55**			
Camiguin	*0.36*	*140.55*			

Figure 1. Geographical distribution of mangrove and brackishwater pond area ; production in brackishwater ponds and mud crab production in the Philippines.

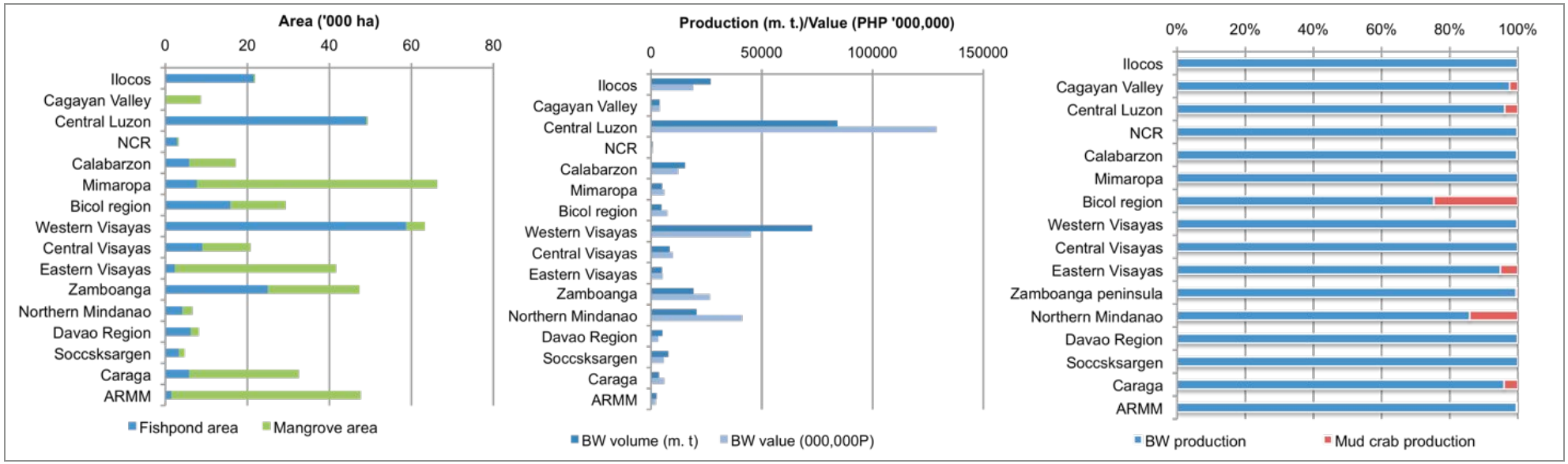
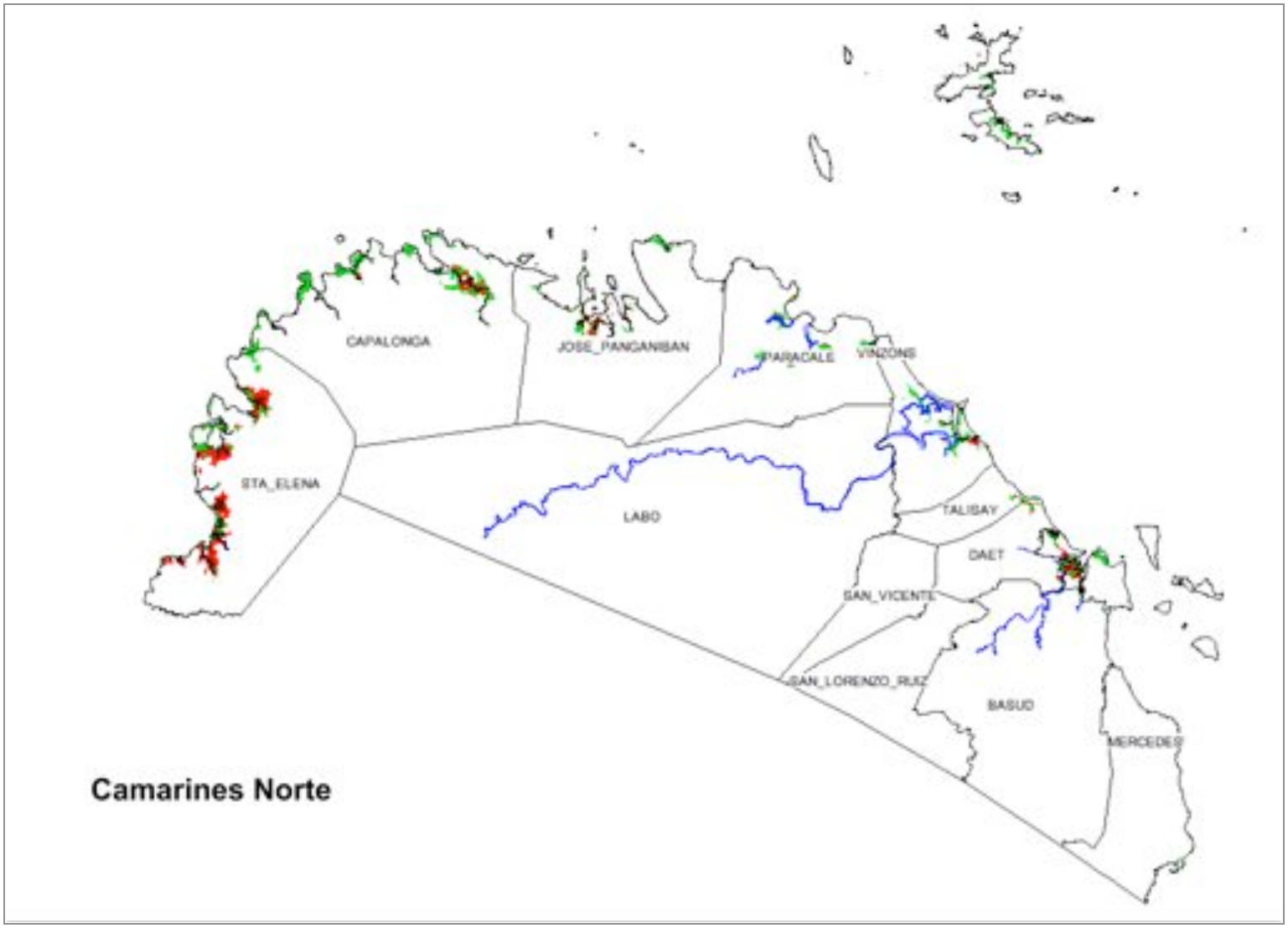
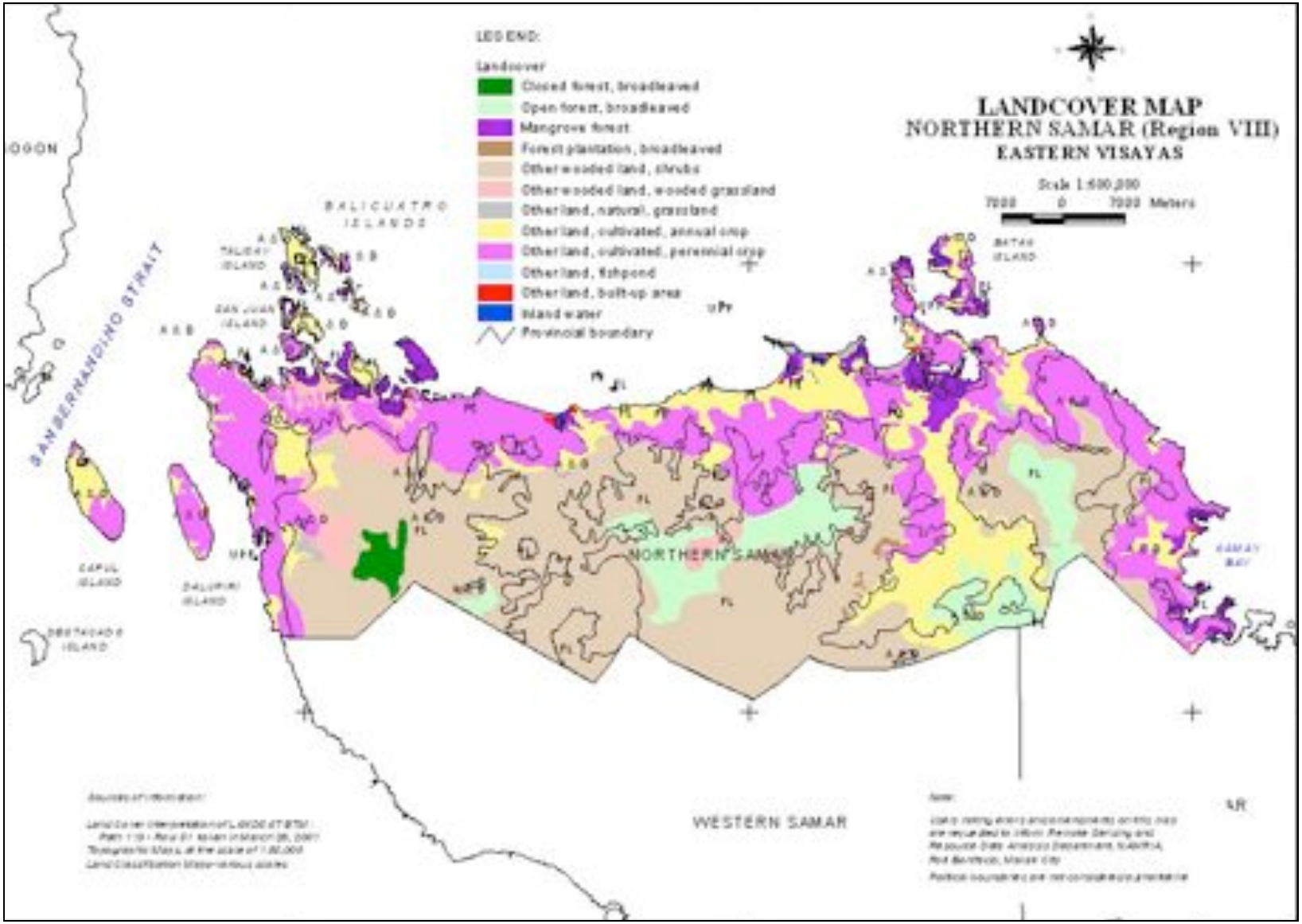


Figure 2. Distribution of fishponds (in red) and mangroves (in green) within the studied areas
Source : Provincal Planning Office of Camarines Norte (Maria Fernanda NAPAO), Pampanga and NAMRIA




LEGEND:
Landcover
Closed forest, broadleaved
Open forest, broadleaved
Mangrove forest
Forest plantation, broadleaved
Other wooded land, shrubs
Other wooded land, wooded grassland
Other land, natural, grassland
Other land, cultivated, annual crop
Other land, cultivated, perennial crop
Other land, fishpond
Other land, built-up area
Inland water
Provincial boundary
LANDCOVER MAP
NORTHERN SAMAR (Region VIII)
EASTERN VISAYAS
Scale 1:500,000
7000 0 7000 Meters
SAN BERNARDINO STRAIT
BALICUATRO ISLANDS
NORTHERN SAMAR
WESTERN SAMAR
CAPUL ISLAND
DALUPIRI ISLAND
BATAG ISLAND

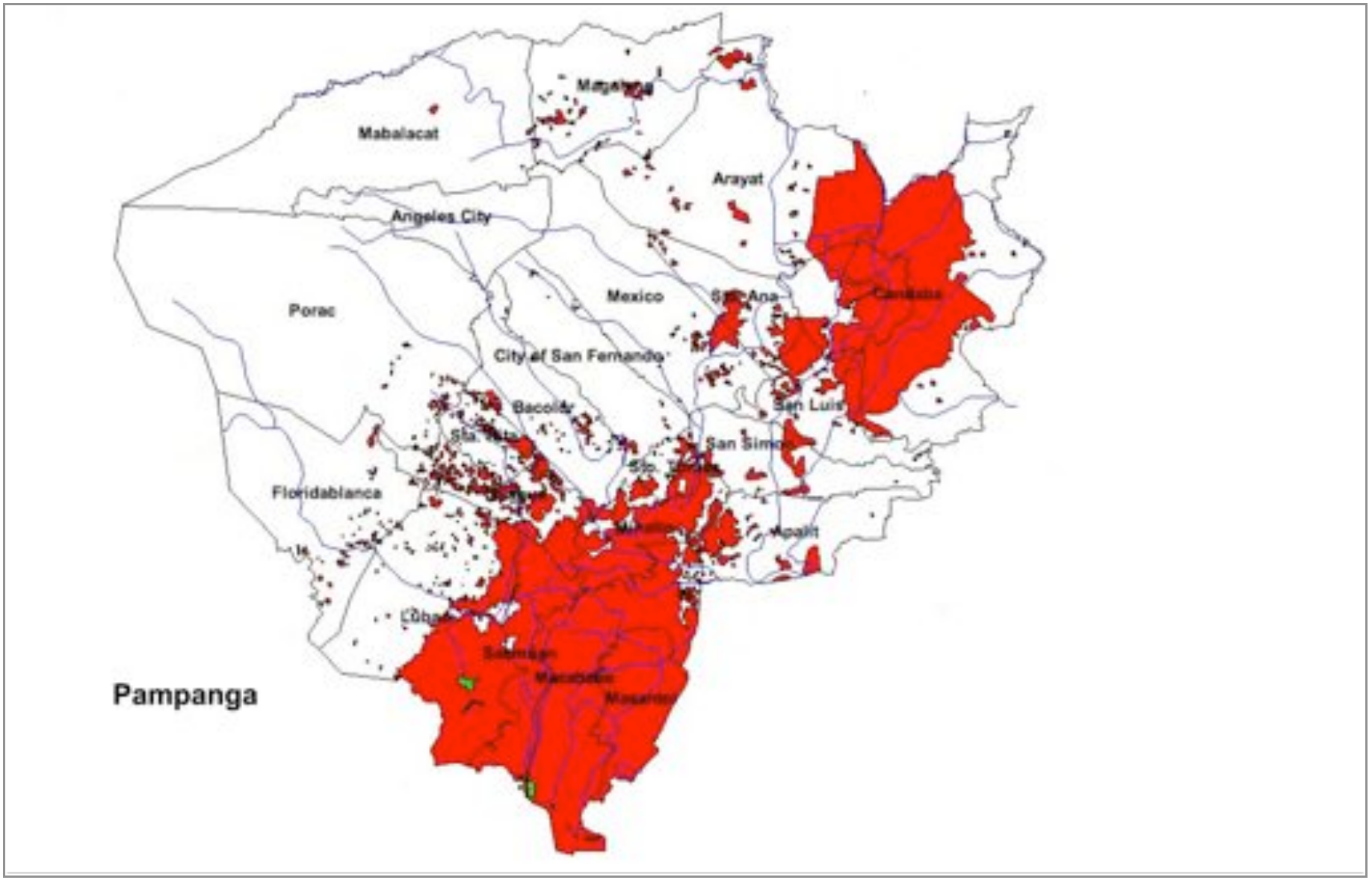

Mabalacat
Arayat
Angeles City
Porac
Mexico
City of San Fernando
Bacolor
San Luis
Floridablanca
Pampanga

Table 2. Technical information on various mud crab culture systems in South East Asia
Sources : Trino & al., 1999[1] ; Lijauco & al., 1980[2], Trino & Rodriguez, 2002 [3] , Samonte & Agbayani, 1992[4], Keenan & al., 1997[5]

	Rearing			Fattening	
Method	Open pond Monoculture[1]	Open pond Polyculture with milkfsh[2]	Mangrove enclosure[3]	Open pond[4]	Cage[5]
Location	Philippines (SEAFDEC)	Philippines (SEAFDEC)	Philippines (SEAFED)	Philippines (SEAFDEC)	Indonesia (Semarang)
Species	*S. serrata* *S. tranquebarica*	?	*S. serrata*	*S. serrata*	*S. paramamosain*
Pond area (m^2)	150	150	200 (pens)	150	9
Stocking density (piece/m^2)	0.5	0.5 (0.2 for milkfish)	0.5	0.5	10
Size of seeds (g)	10 g	36.1 g	20 g	338 g	350
Sex	single	?	mixed	mixed	mixed
Fertilizer	Agriculture lime *1 m. t./ha* Urea (45-0-0) *25 kg/ha* Ammonium phosphate (16-20-0) *50 kg/ha*	Chicken manure *1000 kg/ha*	-	-	-
Feeding rate	8%	?	8%	10%	2.5%
Food items	25% fish 75% mussel	?	75%mussel, 25%bycatch	75% mussel, 25% bycatch	trash and offal
Cover	*Gracilaria*	?	Mangrove	-	Vegetable centre mound
Days of culture/runs	120 days	140 days	160 days	30 days	30 days
Number of runs/year	2	2	2	8	
Average body weight	401.2 g*	191.3 g	326.4 g	464 g	375 g
FCR	2.2*		5.0	-	
Survival rate	98.22%*		56%	86.9%	70-90%
Production	29.5 kg*	23.3 kg	18.28 kg	14.2 kg	
Production	3933 kg/ha/year*	3106 kg/ha/year (+milkfish)	1828 kg/ha/year	7573 kg/ha/year	

** average male/female*

Table 3. Economical analysis of various mud crab culture systems in South East Asia
Source : Trino & al., 1999[1] ; Lijauco, 1980 in Agbayani, 2001[2], Trino & Rodriguez, 2002 [3] , Agbayani, 2001[4], Keenan & al., 1997[5]

Method	Rearing			Fattening	
	Open pond Monoculture[1]	Open pond Polyculture with milkfsh[2]	Mangrove enclosure[3] (200m^2 basis)	Open pond[4]	Cage[5]
Investment costs on a per ha basis					
Capital Cost	27,445	31,566	5,775	31,566	
net enclosure and earthwork	27,445	-	5,775	-	
Operating Cost	118,783	231,118.8/year	2,881	124,200.8	
▪ *Variable cost*	106,327	100,700 201 ,400/year	2,372	12,472	
fertilizer	2,805 *Lime - 700, Urea -687, Am. phos. - 1,418*	1,200 chicken manure – 1.2/kg	-	-	
crab juveniles	37,500 *5,000*7.5/piece*	60,000 5,000*12/piece	850 400*8.5/piece	5,956.8	
milkfish juveniles	-	5,000 2,500*2/piece	-	-	
feeds	43,501	18,000 1,500 kg*12/kg	860	1,920	
labor		14,000 140*100/day	-	2,800 20*140/day	
fresh seaweeds	15,000	-	-		
marketing expenses	-	2,500 1%	176	1,795.2	
material for pen bottom preparation			76		
miscellaneous	7,521 *2% revenues*	-	110 2% revenues		
▪ *Fixed cost*	12,456	29,718	309	24,424.75	
Caretaker's salary	2,500 *500*5mo*	6,000	-	6,000	
Repairs and maintenance	200	-	-	-	
Pond rent	4,000	-	-	-	
Interest on capital	5,619 *8% investment*	7,936	251 8% investment	2,642	
Depreciation	137	15,782.75	58	15,782.75	
Total Investment Cost	**146,228**	**262,674.75**	**8,456**	**440,375**	
Costs and return					
Revenue					
Total harvest crab	1979.33 kg	500 kg	17.77	89.76	
Total revenue crab	376,073 *1979.33kg*190PHP/kg*	250,000/year 2*500kg*250PHP/kg	5509	22,400 89.76*250/kg	
Total harvest milkfish	-	373 kg/year	-	-	
Total revenue milkfish	-	18,650 PHP/year 373*50	-	-	
Less operating costs	118,783	37,531.2	2,681		
Net revenues	257,290	-	2,828	55,319	
Revenues/kg	130	-	160		
Production cost	60/kg	221/kg	185/kg	173/kg	
ROI	176	37+milkfish	49	121%	
Net benefit					

Table 4. Technical performance and economics of mud crab production in polyculture

Polyculture in brackishwater ponds	Province	Number of operators stocking	Stocking density (piece/ha)	Survival (%)	Size at harvest (g)	Nb of cycles/yr	Annual production (kg/ha/year)
Mud crab (*Scylla spp.*)	Pa	7	400	60%	400	2	192
	CN, NS	8, 4	1,000	80%	500	1.5	600
Milkfish (*Chanos chanos*)	Pa	7	1,000	70%	350	2	490
	CN, NS	9, 4	1,000	70%	400	1.2	336
Tiger prawn (*Penaeus monodon*)	Pa	4	35,000	5%	40	2.5	175
	CN, NS	3, 1	25,000	0-50%		1	250
Whiteleg shrimp (*Penaeus vannamei*)	Pa	4	35,000	15%	30	2.5	394
	CN, NS	-	-	-	-	-	-
Tilapia (*Oreochromis spp.*)	Pa	7	5,000	80%	125	1	500
	CN, NS	-	-	-	-	-	-
Total	Pa	7	-	-	-	-	1,357 w/ tiger prawn 1,576 w/ vannamei
	CN, NS	10, 4	-	-	-	-	936 without tiger prawn 1,186 with tiger prawn

Polyculture in brackishwater ponds	Province	Average price (PHP/kg)	Annual production (PHP/ha/year)	seeds (PHP/ piece)	seeds (PHP/ ha/yr	feeds	fertilizers	land	labour	maintenance	others*	Annual cost	Annual net income (PHP/ha/year)
Mud crab (*Scylla spp.*)	Pa	110/piece	52,800	5	4,000	PHP 14,000/yr	PHP 1,300	PHP 30,000/yr	PHP 27,000	PHP 9,000	PHP 6,000	105,550 w/ tiger prawn 108,175 w/ vannamei	93,100 w/ tiger prawn 128,765 w/ vannamei
	CN, NS	300	180,000										
Milkfish (*Chanos chanos*)	Pa	90	44,100	1	2,000								
	CN, NS	90	30,240										
Tiger prawn (*Penaeus monodon*)	Pa	410	71,750	0.12	10,500								
	CN, NS	350	87,500										
Whiteleg shrimp (*Penaeus vannamei*)	Pa	280	110,040	0.15	13,125								
	CN, NS	-	-	-	-								
Tilapia (*Oreochromis spp.*)	Pa	60	30,000	0.35	1,750								
	CN, NS	-	-	-	-								
Total	Pa	-	198,650 w/ tiger prawn 236,940 w/ vannamei	-	18,250 w/ tiger prawn 20,875 w/ vannamei								
	CN, NS	-	297,740										

** others includes pump, fuel, nets, house, boats*

Appendix 10.
Mud crab marketing channels

Table 1. List of live food fish and crustaceans exporters and their status as of June 4, 2010

Company Name	Address
REGISTERED EXPORTERS	
01. Abbe Seafoods Trading	171 Gabriel St., Baclaran, Parañaque City
02. Aida G. Gamuza Lobster Supplier	Brgy. Magamay, Nueva Valencia, Guimaras
03. Asia Dragon Seafoods Dealer	9419 Urma Drive Airport Village, Vitalez, Parañaque
04. Biosolutions International Corporation	15 Clipper Avenue, Bayview Village, Tambo, Parañaque
05. Chen Kao Marine Corporation	2492 Bayview Drive, Tambo, Parañaque City
06. EVM Marine Trading	5332 Moras Street, San Dionisio, Parañaque City
07. Fillas International Trading Corporation	Unit 1 Cargo Forwarders Bldg., Ninoy Aquino Ave., San Dionision, Paranaque
08. Fishwealth Aquafarms, Inc.	Silanguin Bay, Barangay Pundakit, San Antonio, Zambales
09. Fordelon Seafood Products	2316 A. T. Alonzo St., Baclaran, Parañaque City
10. GE Asia International Corporation	1321 Mactan Street, Baclaran, Parañaque City
11. Goldcoast Marine (Export) Inc.	RSTI Compound KM 16, Pamplona, La Piñas
12. Golden Cove Aquamarine Products Corporation	81 Bernardo St., San Rafael Village, Navotas City
13. Golden Harvest Seafoods	9430 Urma Drive Airport Village, Parañaque City
14. Great Ocean Aquamarine Corporation	3420 Maura Street Factor Compound, Don Galo, Paranaque
15. Hao Yun International Export	1476 L. Gabriel St., Baclaran, Parañaque City
16. Harbour View Corporation	Lot 5 Veronica de Leon Street, Brgy. Sto. Niño, Ibayo, Parañaque
17. High Fresh Enterprises	2771 M. delos Santos Street, Tambo, Parañaque City
18. Ibex Aquamarine Development Corporation	Lot 1 Block 1 Dahlia Street, Sto Nino, Paranaque City
19. Inter Marine Center	9574 Jaime Street, Airport Village, Brgy. Vitalez, Paranaque City
20. JC & Lee Aqua Marine Inc.	20 Bethsaida Drive Multinational, Village, Parañaque City
21. Kenneth Aquamarine Products, Inc	5856 Pelaez St., San Dionisio, Parañaque City
22. New Unity Live Fish Trader	L9 B10 Matthew St., Multinational Vill., Moonwalk, Parañaque City
23. Ocean Queen Live Marine Export, Inc.	8099 Pelaez St., San Dionisio, Parañaque City
24. Ocean Treasures Marine Trading	3261 Riverview Compound, Quirino Ave., Tambo, Parañaque City
25. Space Trading	3251 Riverview Compound, Tambo, Parañaque City
26. Seaworld Commercial Trading Corporation	6091 Dimatimbangan Street, Don Galo, Parañaque City
27. Southsea Exclusive Philippines, Inc. (Palawan)	Santa Lucia, Puerto Princesa, Palawan
28. Total Quality Crabs	234 Quirino Avenue, Tambo, Paranaque City
29. White Gold Marine Products	7 McDonough St., Tambo, Parañaque City
30. Wide Vision Enterprises Corporation	803-D Quirino Avenue, Tambo, Paranaque City
31. Yeung Marine Products	4450 D. Campos Street, Don Galo, Paranaque City
32. Yowsen Marine Export	5 McDonough Road, Quirino Avenue, Parañaque City

Company Name	Address
TEMPORARY REGISTERED EXPORTERS	
01. Adjuvant Marketing	64 Brentwood St., PCEV Antipolo City
02. Bhaste "King Crab" Exporter & Wholesaler	Blk 12 Lot 6 Cordova Street, Putatan, Muntinlupa City
03. Kalayaan Pet Shop	1006 Kalayaan Ave., Guadalupe Nuevo, Makati City, Metro Manila
04. Philippine Taiyo Aquafarming Corporation	Guiuan, Eastern Samar
05. Ron-Ron Enterprises	Blk3, Lot3 Teacher's & Policeman Bliss, Balon-Bato, Balintawak, Quezon City
06. VSG Crab Exporter	#63 Santa Lucia Matua, Masantol, Pampanga
07. Wellshare Export And Import Inc.	6079 Sto. Rosario St., Mapulang Lupa, Valenzuela City
08. Ponder Seafoods Products	Brgy. Bulacos, Masantol, Pampanga

Company Name	Address
NON-REGISTERED EXPORTERS	
01. Aqui-Day Trading	C.J. Lumanlan St., Don Anatacio Subd., Cangatba, Porac, Pampanga
02. CJS Golden Sea Harvest	#4B Chapel Rd. CAA Cmpd, Sun Valley, Brgy. 195, Pasay City
03. CYY Marine Exporter	6838 Wagwag St., Clarmen Village, Sucat, Parañaque City
04. ECJ Seafood Products	2827 L. Gabriel St., Baclaran, Parañaque City
05. Great Tiger Trading	B2 Lot71, Casimoro Townhomes, Zapote, Las Piñas
06. Harbour International Trading	Lot 1&2 Blk 14 Manila Harbour Center, R10 Vitas, Tondo, Manila
07. Isla Aquamarine Resources	S. Osmeña St., Gun-ob, Lapu-Lapu City
08. Jamesrie Aquamarine Resources	#3255 Riverview Compound, Tambo, Parañaque City
09. Kingdom Prize Seafoods Products	Villa Esperanza, Tabon, Quezon, Palawan
10. Marong General Merchandise	A.B. Fernandez Ave., Dagupan City, Pangasina
11. MJ Aquamarine Products	142 Bus_Bus St., Jolo, Sulu
12. MM Metal Smith Corp.	UPS5, Parañaque City
13. New Starlife Marine Products	1456 Mactan St., Baclaran, Parañaque City
14. Ocean Palace Marine Products	#8 Los Tamaraos former Sunset Village, Tambo, Parañaque
15. Ocean Square Marine Products	688 El Cano St., San Nicolas, Tondo I/II, City of Manila (NCR)
16. Orient Fresh Enterprises	11B Ortigas St., Pasay City
17. Orient Sea Trading	#80 Ferdinand St., Vista Verde Exec. Village, San Isidro Cainta, Rizal
18. Palawan Ocean Fresh Produce Corp.	Bulalacao, Bataraza, Palawan
19. Phillitess Ocean Fresh Seafoods	#40 L-9, Blk10 Matthew St., Multinational Village, Parañaque City
20. Rainbow Connection International Trading	9552 Gena St., Airport Village, Vitalez, Parañaque City
21. RBED Export	#21 Villa Socorro St., Project 8, Quezon City
22. San Hai Trading	9520 Natalia St., Airport Village, Vitalez, Parañaque City
23. Seintrade Corporation	Don Rafael Bldg., 2-F, 504 Guerrero St., Makati Ave., Makati City
24. Southsea Exclusive Philippines, Inc (Dapitan)	Dapitan City
25. Star Aquamarine Products	9503 Miguela St., Airport Village, Vitalez, Parañaque
26. YG Marine Products	336 Quirino Ave., Baclaran, Parañaque
27. MDR Agriculture Supply	Rm 807 1010 Bldg., A. Mabini St., Ermita , Manila

Table 2. Philippine crab imports in quantity (kg) and value (FOB $US)
Source : BAS, 2007

Imports	Frozen		Other		Prepared/preserved		Fat, prepared/preserved	
Year	*kg*	*US$*	*kg*	*US$*	*kg*	*US$*	*kg*	*US$*
1994	24,664	37,768	-	-	1,511	18,512	-	-
1995	437	1,446	366	2,607	5,716	25,049	123	699
1996	14,269	62,032	2025	2,408	39,949	375,31	-	-
1997	1,676	101,008	-	-	17,197	33,656	-	-
1998	13,892	126,134	1452	1,5	29,693	40,031	-	-
1999	100,559	216,806	-	-	17,461	25,682	1	1,2
2000	17,945	82,951	-	-	46,426	157,297	-	-
2001	40,891	114,278	2	59,535	55,167	130,707	6187	10,861
2002	24,387	65,88	-	-	84,663	129,036	-	-
2003	27,096	13,073	400	1	117,548	192,352	-	-
2004	27,152	12,644	-	-	203,799	229,245	500	150
2005	4,078	44,841	-	-	115,315	145,239	17	909
2006	119,851	174,702	4,356	1,249	95,424	152,8	60,272	955,051

Table 3. Philippine crab exports in quantity (kg) and value (FOB $US)
Source : BAS, 2007

Exports	Frozen		Other		Prepared/preserved		Fat, prepared/preserved	
Year	*kg*	*US$*	*kg*	*US$*	*kg*	*US$*	*kg*	*US$*
1994	1,651,777	6,244,987	.	.	246,001	2,895,848	39,792	352,824
1995	1,850,479	7,451,062	359,786	3,394,543	253,059	3,734,862	1,981	12,582
1996	2,082,331	8,531,304	1,106	12,209	885	1,126,403	304	23,728
1997	3,376,564	13,123,134	.	.	70,942	859,499	2,829	21,715
1998	1,661,884	6,331,266	1,098,907	4,396,640	87,115	1,395,932	1,511	9,251
1999	128,531	438,592	3,083,507	11,742,935	182,849	1,135,359	1,941	8,881
2000	353,205	1,082,178	4,139,722	16,765,939	81,793	1,271,519	3,558	18,369
2001	96,379	301,156	4,815,156	19,096,420	660,229	10,399,158	8,099	996,139
2002	100,437	266,808	4,191,566	16,174,373	1,194,749	16,536,794	2,739	17,1
2003	31,528	1,034,263	3,673,743	13,954,319	1,199,139	17,516,469	17,772	255,538
2004	191,571	741,226	2,331,491	12,213,567	1,438,250	18,837,718	4,917	22,217
2005	11,188	463,816	1,514,899	7,192,738	1,978,583	29,526,489	47,545	445,595
2006	53,559	412,037	1,956,215	9,597,484	1,616,026	23,683,920	101,148	263,291

Table 4. Quantity (kg except for Live Animals in heads) and FOB value of crab exports and imports in 2007-2008

Exports	2007		2008	
	kg	**US$**	**kg**	**US$**
Frozen	76,192	279,217	64,263	171,802
Live	1,726,546	8,666,614	1,625,354	9,834,064
Fresh Or Chilled	.	.	36	60
Fat, Prepared/Preserved	374,719	5,486,450	356,201	6,595,109
Other	1,726,487	25,140,301	1,542,004	18,192,562
Total	3,903,944			

Table 5. Country of destination of crab exports
Source : BAS, 2008

		2007		2008	
		Quantity (kg)	*F.O.B. Value (US$)*	*Quantity (kg)*	*F.O.B. Value (US$)*
Crabs, Frozen	**Total**	**76,192 (1.9%)**	**279,217**	**64,263**	**171,802**
	China, People's Republic Of	991	5,954	.	.
	Guam	4,469	16,649	1,767	7,269
	Hawaii	.	.	177	765
	Hongkong	6,999	34,311	1,933	7,690
	Indonesia (Includes West Irian)	34,398	76,840	.	.
	Japan (Excludes Okinawa)	1,511	5,618	687	2,418
	Korea, Republic Of South	7,594	54,141	41,548	112,775
	Malaysia (Federation Of Malaya)	262	1,048	.	.
	Pacific Trust Territory	50	250	.	.
	Saudi Arabia	.	.	20	100
	Singapore	1,260	5,138	250	1,040
	Taiwan (Republic Of China)	13,041	35,484	17,656	37,764
	United States Of America	5,617	43,784	225	1,981
Crabs, Live	**Total**	**1,726,546 (44.2%)**	**8,666,614**	**1,625,354**	**9,834,064**
	China, People's Republic Of	85,129	484,803	54,006	347135
	Guam	19,674	69,967	8,168	32749
	Hongkong	853,891	3,681,555	1,112,872	6299215
	Japan (Excludes Okinawa)	650	4,950	8,843	50401
	Korea, Republic Of South	8,407	48,425	3,381	151257
	Macau (Portuguese Asia)	.	.	1,200	6000
	Malaysia (Federation Of Malaya)	2,300	10,500	.	.
	Pacific Trust Territory	2,640	10,957	1,432	6377
	Pakistan	.	.	.	.
	Palau, Rep. Of	703	3,750	1,257	6576
	Peru	.	.	140	700
	Singapore	530,767	3,393,207	378,687	2606046
	Spain	250	1,000	.	.
	Taiwan (Republic Of China)	221,821	956,180	55,240	326975
	Thailand	.	.	50	420
	United States Of America	314	1,320	78	213
Crabs, Fresh Or Chilled	**Total**	**.**	**.**	**36**	**60**
	Guam	.	.	36	60
Crab Fat, Prepared/Preserved	**Total**	**374,719 (9.6%)**	**5,486,450**	**356,201**	**6,595,109**
	Australia	431	1,916	358	800
	Canada	2,040	5,100	.	.
	Guam	490	1,524	632	1,963
	Hongkong	39	89	1,404	16,459
	Japan (Excludes Okinawa)	1,003	3,848	508	1,383
	Korea, Republic Of South	38	709	.	.
	New Zealand (Excludes Western Samoa)	294	587	175	523
	Pacific Trust Territory	792	1,584	.	.
	Qatar	33	195	578	1,168
	Singapore	14	50	.	.
	Thailand	3,704	15,000	.	.
	United Arab Emirates	920	3,493	1,793	5,140
	United States Of America	364,921	5,452,355	350,753	6,567,673
Other Than Crab Fat, Prepared Or Preserved Crab Meat (?)	**Total**	**1,726,487 (44.2%)**	**25,140,301**	**1,542,004**	**18,192,562**
	Canada	.	.	272	4,425
	China, People's Republic Of	.	.	8	49
	Guam	17	182	1,471	3,052
	Hongkong	4,466	11,397	23,400	131,758
	Japan (Excludes Okinawa)	202	2,434	.	.
	Korea, Republic Of South	80	2,215	.	.
	Qatar	.	.	29	259
	Saudi Arabia	.	.	33	100
	United Arab Emirates	427	1,033	.	.
	United States Of America	1,721,204	25,122,855	1,504,791	17,997,227
	Vietnam	91	185	12,000	55,692