

**Agriculture,  
Fishery and  
Forestry**

***Upland Palay  
Farming***

## 2.1.1 INTRODUCTION

### 2.1.1.1 Industry Description

The Philippines has about 9.97 million hectares of agricultural land. An estimated 4.01 million hectares of these lands or about 40 percent are planted to palay. Of the total palay areas, almost half are situated in lowland areas while the other half are in upland areas (NSO, 1991). Lowland palay areas are mostly flat and plain and irrigated while upland palay areas are on rolling and hilly terrain and are usually rainfed or non-irrigated. The latter is the subject of this study.

Palay industry continues to play an important role in the Philippine economy. It serves as the main source of the country's staple food, rice. It also employs a significant proportion of the country's rural population, either as farm operator or as wage earners. In terms of its contribution to the GVA in 1995, the palay industry accounted for more than 16 percent of the total output of the agriculture sector and almost 4 percent of the country's GDP (NSCB, 1996).

Due to the importance of the industry, the government's efforts of continued expansion of palay farms and intensive cultivation by increased cropping intensity and intercropping practices have been pursued vigorously. The use of modern inputs in production, adoption of high yielding varieties and the availability of irrigation water, were some of the measures adopted to increase palay production.

In the past, growth of palay industry was primarily the result of continued expansion of land planted to palay. Other factors like changes in cropping intensity, technology and productivity have only minimally contributed to the increase in palay production during the period. In the early eighties, however, a shift to increasing land productivity at a very high margin has started (PCSD, 1990). For the period 1988 to 1994, palay production grew at an average of 2.6 percent annually from 5.4 million MT in 1988 to 6.4 million MT in 1994. Palay productivity likewise improved marginally from 2.26 MT in 1988 to 2.37 MT in 1994.

The growing demand for higher production because of growing population has threatened the sustainability of the country's natural resources and the viability of the state of the environment. Intensive farm cultivation practices and excessive application of chemical fertilizers and pesticides are some of the factors found to contribute to the degradation of the environmental media (Francisco, 1996). Moreover, other production processes although at a minimal rate, also affect the environment.

### 2.1.1.2 Scope and Limitations of the Study

The study measures the degradation caused by upland palay farming to environmental media such as land, water and air. It also illustrates how environmental degradation of upland palay farming was accounted for and valued using the maintenance cost method - a method that represents the expenditures to be incurred to avoid environmental degradation or to eliminate the effects of such degradation after the activity has taken place.

The study focuses only on palay farming activities located in upland areas, considering that environmental degradation is more pronounced in upland areas than in lowland areas. Areas devoted to upland palay farming are approximately 20 percent of total areas devoted to palay farming. Environmental degradation accounted for in the study was limited to land and water degradation.

For degradation to land, only the resulting nutrient loss from soil erosion is accounted for, covering only three macro nutrients - nitrogen (N), phosphorus (P) and potassium (K). Nutrient loss as a result of plant uptake and leaching was not considered. For

degradation to water, only five-day biochemical oxygen demand (BOD<sub>5</sub>) and suspended solids (SS) are included.

To account for the differences in upland palay farming practices in the country, estimation of the physical accounts was done by region.

### **2.1.1.3 Production Process and Pollutants Generated**

The cultivation of palay involves several production processes namely: seed treatment, cultivation and land preparation, transplanting, insect and pest control, weed control, fertilization, rouging and harvesting. These production processes are shown in Figure 2.1.1. The corresponding inputs and waste materials that are generated and the environmental degradation that resulted from the process are indicated.

### **2.1.1.4 Effects to Environmental Media**

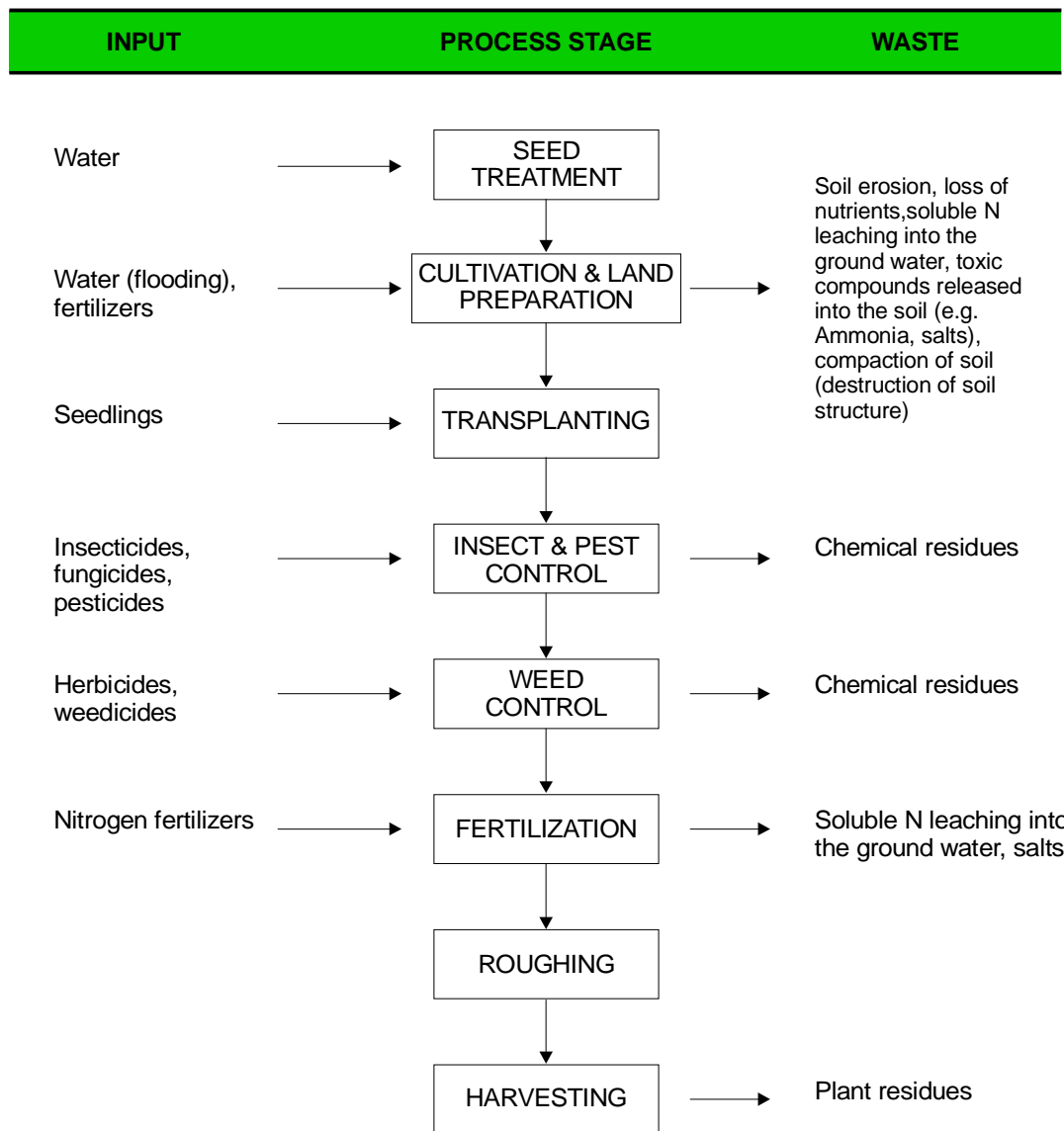
#### **2.1.1.4.1 Land**

Although intensive cultivation and increased cropping intensity in palay farms increased palay production, it also resulted in the degradation of land due to soil erosion or the loss of nutrients from the soil. Soil erosion tends to lower the quality of soil which may cause irreparable loss of nutrients in the soil thereby affecting the growth and yield of crops. Nutrients identified to be essential for plant growth are nitrogen (N), phosphorous (P), potassium (K), iron (Fe), molybdenum (Mo), manganese (Mn), copper (Cu), calcium (Ca), magnesium (Mg), sulfur (S), zinc (Zn), boron (Bo) and chlorine (Cl). Among the identified nutrients, N, P and K are the most important nutrients necessary for plants to sustain their growth (Espino, 1995). This damaging effect to land is the main concern of this study.

Other damaging effects of soil erosion are sedimentation of water bodies, ozone layer depletion, soil salinization, etc.

#### **2.1.1.4.2 Water**

Several discharges to water from palay farming include agrochemical residues, nitrates and ammonium which stemmed from excessive applications of inorganic chemicals and fertilizers that are carried by runoff erosion to water bodies like lakes and rivers. High concentration of nitrates and ammonium often lead to the contamination of ground water. It also carries, through runoff erosion, soil nutrients, soil sediments, biochemical oxygen demand (BOD<sub>5</sub>) and suspended solids (SS). BOD<sub>5</sub> and SS were identified as major pollutants to water that can lead to eutrophication which is characterized by ecological imbalance in water and soil due to excessive supply of plant nutrients in the form of phosphates and nitrogen compounds (Geron, 1994). Eutrophication creates damage to living organisms in water bodies as it leads to algal blooms which cause massive fish kills and may eventually result to the disruption of aquatic life due to oxygen depletion in the water. The physical account presented in this study covers BOD<sub>5</sub> and SS as pollutants to water.



Source:  
 Selected Technical Information on Agricultural  
 Crops, Fishery and Forestry, NEDA

FIGURE 2.1.1 UPLAND PALAY PRODUCTION PROCESS

#### 2.1.1.4.3 Air

Palay farms when submerged in water during its growing stage emit air concentrations of methane gas, aside from the release of carbon monoxide and carbon dioxide (Francisco, 1994). Methane gas emissions trap part of the thermal radiation from the earth's surface that contribute to global warming. Other discharges to air include chemical and fertilizer residues from the excessive application of pesticides and chemical fertilizers as well as soil particulates from continuous soil erosion.

Solid wastes generated from palay production such as rice straws, rice husk, and other plant residues are normally discharged in palay fields wherein its beneficial effects, aside from reducing the effects of erosion, include the supply of organic matter to form part of the available nutrients in the soil. These wastes when burned pollute the air with emissions of particulate matter, volatile organic compounds, carbon monoxide and carbon dioxide. Palay residues also create odor when these rot in the field.

Due to unavailability of data, damaging effects of upland palay farming to air was not estimated in this study.

#### 2.1.1.5 Measures to Prevent Degradation to Environmental Media

The most apparent degradation from palay farming causing serious damage to the environment relates to the degradation of land due to soil erosion that usually occurs in upland palay farming. The University of the Philippines at Los Baños, Laguna (UPLB) Agroforestry Program in 1994 showed that the effects of soil erosion can be prevented or reduced when appropriate measures are adopted. These include the use of vegetative measures like cover cropping, contour/buffer strip cropping, multiple/relay cropping/crop rotation, mulching, hedgerows, fascines and wattlings as well as the use of engineering measures, both mechanical and structural, like conservation tillage, terracing, diversion ditches/drainage canals, rockwalls, checkdams/drop weirs, farmponds/water impounding dam and riprap.

#### 2.1.1.6 Assumptions

In coming up with the physical and monetary estimates, several assumptions were employed. These are:

1. All areas devoted to upland palay farming, at varying degrees (slight, moderate, and severe), are subject to soil erosion.
2. The same parameters such as erosion rates obtained from the 1990 study were used for 1988-1994.
3. Some of the ratios used in the study were based on the study that was conducted in four areas of Mindanao. No adjustments were made to account for regional differences in the ratios.
4. The equivalent nutrient loss due to on-site erosion is the proxy estimate of the degradation to land of upland palay farming while the estimated degradation to water was based on the nitrogen loading of off-site soil erosion.
5. In the monetary estimation of degradation, it was assumed that all upland palay farm areas are already degraded.
6. The valuation of degradation was limited to maintenance cost – referring to the avoidance of soil erosion.

## 2.1.2 SOURCES AND METHODS

### 2.1.2.1 Data Sources

The main sources of data for the study were culled from agricultural surveys, administrative reports and special studies from different research institutions.

The National Statistics Office (NSO) from the 1980 and 1991 Census of Agriculture (CA) generated data on total physical area devoted to palay farming. Data on area by type of farm (irrigated and rainfed) came from the Bureau of Agricultural Statistics (BAS).

The Bureau of Soils and Water Management (BSWM), through its Agricultural Land Management and Ecological Division (ALMED), provided data on average soil loss, total eroded areas and erosion factors by region and by type of erosion such as slight, moderate and severe erosion. Provincial data on land use disaggregated by type of crop and by pedo-ecological zones (lowland, upland, hillyland, highlands, etc.) were obtained from the BSWM.

A special study on Agricultural Production and the Environment for Mindanao Regions in the Philippines, conducted by the ENRA Component of the Statistical Development Analysis Project under the Philippine Statistical Association (PSA), was the source of some parameters and indicators used to estimate BOD and SS for water pollution and estimates of soil sediment discharge to catchment areas. The same study also provided indicators on the estimated pollution control cost per hectare of degraded palay farms.

A study on Valuation of Direct Environmental Waste Disposal Services conducted by ENRAP III provided the regional estimates of nutrient equivalent (NPK) for every ton of soil loss, a parameter used for the estimates of total nutrient loss due to palay farming.

A report on Selected Technical Information on Agricultural Crops, Fishery and Forestry, published by the National Economic Development Authority (NEDA) in 1975, was the source of information on different production processes in palay farming. Information on appropriate measures on soil and water conservation was obtained from UPLB Agroforestry Program.

Other indicators like agricultural wage rates (national) in farm households, particularly for palay workers, and the corresponding wage rate index were obtained from the BAS.

### 2.1.2.2 Estimation Methodology

#### 2.1.2.2.1 Physical Estimation

- Soil Erosion

The estimates on environmental degradation to land were expressed in terms of the equivalent nutrient loss from the estimates of soil loss due to palay farming. Soil loss estimation is based on soil erosion which is categorized either as slight (SE1), moderate (SE2) and severe (SE3). These varied erosion levels are calculated for each region in the country after identifying the total area subject to erosion (TSEA), which in this study, is limited to areas devoted to upland palay farming (Appendix Table 2.1.1). Benchmark data on land area devoted to palay farming are from the 1980 and 1991 CA. For other years, estimates were arrived at using the trends of average growth rates computed for 1980 and 1991 using the geometric formula. To estimate total soil erosion (TSE), the following equations were used:

$$\text{Total Area Subjected to Erosion (TSEA)} = \text{AHA} \times \text{UPR} \quad \text{Eq. 1}$$

where:

AHA = adjusted area harvested planted to palay (Reported area is adjusted by 5 percent for under coverage)

UPR = ratio of upland palay farming to total area for palay farming

$$\text{Total Soil Erosion (TSE)} = \text{SE1} + \text{SE2} + \text{SE3} \quad \text{Eq. 2}$$

where:

SE1 = slight erosion

SE2 = moderate erosion

SE3 = severe erosion.

TSEA for each region was subdivided into three areas depending on level of erosion rate. Each SE was calculated as:

$$\text{Soil Erosion for each type (SE}_j) = \text{TSEA} \times \text{SE}_{j,r} \times \text{SER}_j \quad \text{Eq. 3}$$

where:

SE<sub>j,r</sub> = ratio of total area subject to (j) type of erosion

SER<sub>j</sub> = soil erosion rate for (j) type of erosion

j = 1,2,3

In computing for the total soil erosion, equations 2 and 3 are combined to form the equation:

$$\text{TSE} = \sum (\text{TSEA} \times \text{SE}_{j,r} \times \text{SER}_j) \quad \text{Eq. 4}$$

For example, total erosion for the Cordillera Administrative Region (CAR) is calculated as:

$$\begin{aligned} \text{TSE}_{\text{CAR94}} &= [(49,562 \times .3097 \times 6.5) + (49,562 \times 0.4425 \times 17.7) + (49,562 \times 0.2478 \times \\ &\quad 59.4)] \\ &= 99,771 + 388,182 + 729,519 \\ &= 1,217,472 \text{ MT} \end{aligned}$$

Table 2.1.1 gives a summary of the TSE due to upland palay farming for each region in 1994. The variables for SE<sub>j,R</sub> and SE<sub>R,j</sub>, are shown in Appendix 2.1.2.

**TABLE 2.1.1 TOTAL SOIL EROSION (TSE) DUE TO UPLAND PALAY FARMING BY REGION, IN THOUSAND METRIC TONS, 1994**

Region	Total Palay Area (AHA) in ha.	Upland Ratio (UPR)	Upland Palay Area (TSEA) in ha.	Soil Erosion (SE)			
				Total Soil Erosion (TSE)	Slight Erosion (SE1)	Moderate Erosion (SE2)	Severe Erosion (SE3)
CAR	71,642	0.6918	49,562	1,217.4	99.8	388.2	729.5
I Ilocos Region	333,796	0.0462	15,421	607.5	130.2	190.9	266.4
II Cagayan Valley	398,518	0.0443	17,654	675.6	90.8	380.9	203.8
III Central Luzon	560,144	0.0186	10,419	191.9	31.3	68.8	91.9
IV Southern Tagalog	442,408	0.3153	139,491	3,057.4	176.4	1,609.8	1,271.2
V Bicol Region	311,683	0.1356	42,264	1,426.2	553.8	603.0	269.5
VI Western Visayas	532,566	0.3643	194,050	5,779.3	375.9	1,704.1	3,699.3
VII Central Visayas	113,947	0.7572	86,281	881.0	27.0	265.6	588.4
VIII Eastern Visayas	207,722	0.1724	35,811	936.0	93.3	217.3	625.4
IX Western Mindanao	121,674	0.3279	39,897	500.4	39.3	152.0	309.2
X Northern Mindanao	180,895	0.0455	8,231	190.7	14.7	53.3	122.7
XI Southern Mindanao	193,075	0.0608	11,739	355.9	60.3	48.0	247.4
XII Central Mindanao	208,520	0.0459	9,571	259.8	37.9	73.5	148.4
ARMM	157,427	0.1869	29,423	597.0	77.2	172.9	346.9
PHILIPPINES	3,834,117		689,815	16,675.9	1,807.8	5,928.2	8,940.0

To divide total soil erosion (TSE), by those that are delivered into the water bodies (off-site erosion - OFSE) and those that are transferred into other land areas (on-site erosion - ONSE), a soil delivery ratio (SDR) was used. In this study, SDR was assumed to be 20 percent. Hence:

$$TSE = OFSE + ONSE$$

where:

$$\text{Off-site soil erosion (OFSE)} = TSE \times \text{SDR or,}$$

$$\text{Off-site soil erosion (OFSE)} = 0.2 TSE \quad \text{Eq. 4}$$

$$\text{On-site soil erosion (ONSE)} = (1 - 0.2) TSE \quad \text{Eq. 5}$$

The 20 percent SDR was used to estimate the amount of sediment delivered into the catchment areas. This parameter was obtained from the ENRAP III Study on Upland Soil Resources of the Philippines (Francisco, 1993). The same ratio was applied for the years 1988 to 1994. Consequently, the estimated volume of soil erosion transferred to other lands is 80 percent of the total soil erosion (Appendix Table 2.1.3).

- Nutrient Equivalent

The NPK equivalent representing the nutrient loss due to soil erosion was computed by multiplying the estimated soil erosion by the nutrient content of eroded soil. Nutrient content was measured in terms of kilograms per ton of soil loss (Appendix Table 2.1.4).

$$\text{Nutrient Loss (NL)} = \text{TSE} \times \text{N-C} \quad \text{Eq. 7}$$

where:

N-C = Nutrient content per unit of erosion

For example, to estimate the nutrient equivalent of Nitrogen loss:

$$\text{NLN} = \text{TSE} \times \text{NNC}$$

where:

NLN = Nitrogen equivalent of the nutrient loss in kg

NNC = Nitrogen content per unit of erosion

The same formula was used for the estimation of P (Phosphorus) and K (Potassium) nutrient equivalent of soil erosion. The ENRAP Study on Valuation of Direct Environmental Waste Disposal Services provided a parameter on equivalent nutrient loss in terms of NPK by region (Table 2.1.2). This parameter was derived by taking into account several variables namely: average fertilizer applied per hectare, cropping intensity, area planted and percentage of farmers applying fertilizers.

- Degradation to land

The estimated NPK equivalent (Appendix 2.1.4) representing the nutrient loss on on-site erosion served as an indicator for the estimation of environmental degradation to land in physical terms. This was achieved by replacing TSE with ONSE in Eq. 7. Hence the formula is:

$$\text{Nutrient Loss to Land (NL}_{\text{ONSE}}) = \text{ONSE} \times \text{N-C} \quad \text{Eq. 8}$$

- Degradation to water

The estimates of environmental degradation to water in physical terms were expressed in terms of BOD and SS. The available parameters for estimating BOD and SS were based on nitrogen loading. Nitrogen loading was assumed to be the Nitrogen (N) nutrient loss due to OFSE. The nitrogen loading from off-site soil erosion was then multiplied by the corresponding effluent factors as shown in the following equations:

$$\text{NL}_{\text{OFSE}} = \text{OFSE} \times \text{NNC} \quad \text{Eq. 9}$$

where:

NL<sub>OFSE</sub> = Nitrogen loss equivalent of off-site soil erosion

BOD = NL<sub>OFSE</sub> × EF<sub>BOD</sub> or,

$$\text{BOD} = \text{NL}_{\text{OFSE}} \times 1.3 \text{ kg/kg of nutrient loss} \quad \text{Eq. 10}$$

where:

$\text{EF}_{\text{BOD}}$  = Effluent factor for  $\text{BOD}_5$  which was assumed to be 1.3 kg per kg of nutrient loss equivalent

$$\text{SS} = \text{NL}_{\text{OFSE}} \times \text{EF}_{\text{SS}} \text{ or,}$$

$$\text{SS} = \text{NL}_{\text{ss}} \times 257.99 \text{ kg/kg of nutrient loss} \quad \text{Eq. 11}$$

where:

$\text{EF}_{\text{SS}}$  = Effluent factor for SS which was assumed to be 257.99 kg per kg of nutrient loss equivalent

**TABLE 2.1.2 AVERAGE N, P, K EQUIVALENT PER TON OF SOIL LOSS BY REGION, IN KILOGRAMS, 1988**

Region	NUTRIENT		
	N	P	K
CAR	2.20	0.07	0.04
I Ilocos Region	1.68	0.04	0.12
II Cagayan Valley	2.00	0.04	0.17
III Central Luzon	2.41	0.05	0.18
IV Southern Tagalog	2.21	0.06	0.68
V Bicol Region	3.38	0.04	0.22
VI Western Visayas	3.25	0.11	0.80
VII Central Visayas	3.79	0.05	1.11
VIII Eastern Visayas	3.79	0.05	1.11
IX Western Mindanao	2.29	0.07	0.16
X Northern Mindanao	2.64	0.03	0.18
XI Southern Mindanao	1.81	0.04	0.48
XII Central Mindanao	4.80	0.04	0.25
ARMM	3.31	0.04	0.37

Source: Valuation of Direct Environmental Waste Disposal Services, ENRAP III, December 1995

### 2.1.2.2.2 Monetary Estimation

The monetary estimates of environmental degradation were valued based on the maintenance cost method. While the estimates of environmental degradation in physical terms were estimated by region, the estimates in monetary terms can only be done for the national level since current available data are very limited.

In the valuation of environmental degradation, only those that are beyond the absorptive capacity of the environment were taken into account. In this study, the assumption that environmental degradation had already taken place was based on the results of the PSA Study on Agricultural Production and the Environment for Mindanao Regions conducted in 1990. The study showed that palay farms in four regions in Mindanao are already degraded. An estimate of costs was also computed for degraded upland palay farms in Mindanao which adopted both vegetative and engineering measures at varying capacity rates of reducing soil erosion and water pollution.

The study arrived at an estimate of annual maintenance costs (MC90) which was used as benchmark estimates of costs. Maintenance costs (MC90) included the expenditures for preventing the effects of soil and water pollution using various technologies. Separate cost estimates was made for each level of erosion.

- 1) (MC1) ₱115/ha - include cost of an agronomic cover for slightly eroded farm
- 2) (MC2) ₱745/ha - include cost of a sloping agriculture land technology (SALT) for a moderately eroded farm.
- 3) (MC3) ₱1,100/ha - include cost of maintaining the vegetative and engineering measures (SWCM) for severely eroded farms.

The total cost of controlling soil erosion (TMCSE) was derived by multiplying the total eroded area with the estimated cost per hectare for each type of soil erosion, i.e., slight, moderate and severe erosion. This is illustrated in the following equations:

$$\text{TMCSE} = \text{MCSE1} + \text{MCSE2} + \text{MCSE3} \quad \text{Eq. 12}$$

MCSE was calculated as:

$$\text{MCSE}_j = \text{SE}_j \times \text{MC}_j \quad \text{Eq. 13}$$

where:

$$\begin{aligned} \text{MC}_j &= \text{maintenance cost for each (j) type of erosion} \\ j &= 1,2,3 \end{aligned}$$

Estimates of annual costs for the succeeding years were obtained by extrapolating the 1990 annualized cost using the computed index of legislated wage rates for palay farmers obtained from the BAS (Appendix Table 2.1.4). Wage rates were used as an indicator since cost of labor accounted for a significant proportion of the total costs.

### 2.1.2.2.3 Environmentally Adjusted Net Value Added (EVA)

The estimates of the EVA were derived by subtracting from the net value added (NVA) the cost of environmental degradation taking into account the degradation caused by palay farming to land, water and air. In this study, only the cost of degradation to land and water were considered in terms of its equivalent nutrient loss from soil erosion as well as in terms of BOD<sub>5</sub> and SS discharges.

NVA represents the GVA less the cost of depreciation of fixed assets. The sector's GVA represents the factor payments to production, namely: compensation, indirect taxes less subsidies, depreciation and net operating surplus. The GVA is estimated by deducting from the gross output, the value of the total intermediate inputs used during the process of production.

This methodology of estimating the EVA applies to all economic activities covered in this publication.

## 2.1.3 RESULTS

### 2.1.3.1 Physical Estimates

#### 2.1.3.1.1 Degradation to land

In physical terms, degradation to land as estimated in this study was evaluated by the amount of nutrient loss due to soil erosion of three (3) major nutrients: nitrogen (N), phosphorous (P) and potassium (K). During the period, the equivalent nitrogen content of eroded soil ranged from 33,000 MT in 1990 to 39,000 MT in 1994. The results are reflective of the trends in the estimated areas devoted to upland palay farming. In 1994, nitrogen, which made up a significant proportion of the total nutrient in the soil, accounted for 87 percent of the total nutrient loss in the soil. The remaining nutrient losses are accounted for by phosphorous and potassium at 11 percent and 2 percent, respectively. Nutrient losses, when expressed in thousand MT, correspond to 197 MT of nitrogen, 26 MT of potassium and 4 MT of phosphates (Table 2.1.3).

#### 2.1.3.1.2 Degradation to water

Water pollutants covered in the study were BOD and SS which were the results of off-site soil erosion. In 1994, SS, which contributed the bulk of discharges in water, generated a total of 2.49 million MT while BOD discharges reached 13,000 MT during the year.

The results of the study should be interpreted in relation to other economic activities as well as natural processes that cause soil erosion. These include logging operations, road building, and more importantly, natural processes such as erosion accelerated by wind and rain. The relative magnitude of soil erosion from these sources would provide a better assessment of the environmental consequences of palay farming. Nonetheless, the succeeding section on monetary valuation of soil erosion will provide an indication of the absolute importance or non-importance of the environmental consequences of palay farming.

**TABLE 2.1.3 ESTIMATES OF ENVIRONMENTAL DEGRADATION, IN THOUSAND METRIC TONS, 1988-1994**

POLLUTANT	1988	1989	1990	1991	1992	1993	1994
<b>To Water</b>							
BOD	12	12	11	12	11	12	13
SS	2,330	2,362	2,138	2,337	2,217	2,283	2,491
<b>To Land</b>							
N	36	37	33	36	34	35	39
P	0.9	0.9	0.8	0.9	0.9	0.9	1.0
K	7	8	7	8	7	7	8

### 2.1.3.2 Monetary Estimates

The preliminary estimates of the value of environmental degradation from upland palay farming cover only an approximation of the total costs incurred to prevent the degradation to land and to water. At current prices, the estimated value of the degradation as measured in terms of the control cost of soil and water pollution due to soil erosion, reached a high of P1,466 million in 1994 from P128 million in 1988, growing at an annual average rate of 16.9 percent. From the period 1988 to 1990, the estimated value of environmental degradation grew by more than 70 percent during the period. From 1991 to 1992, however, a decelerating trend was noted but started to peak up from 1992 continuing until 1994.

Average annual costs of degradation from upland palay farming are P 45 million, P310 million and P 231 million, for slightly, moderately and severely eroded palay areas, respectively. This ranking was determined by the distribution of palay farms subject to erosion as well as the cost of soil and water conservation measures to control erosion (Appendix Table 2.1.5). For instance, in 1994, moderately eroded palay farms covered 44 percent of total area; slightly eroded areas, 33 percent; and severely eroded areas, 23 percent. The unit maintenance cost, however, was highest for areas subject to severe erosion.

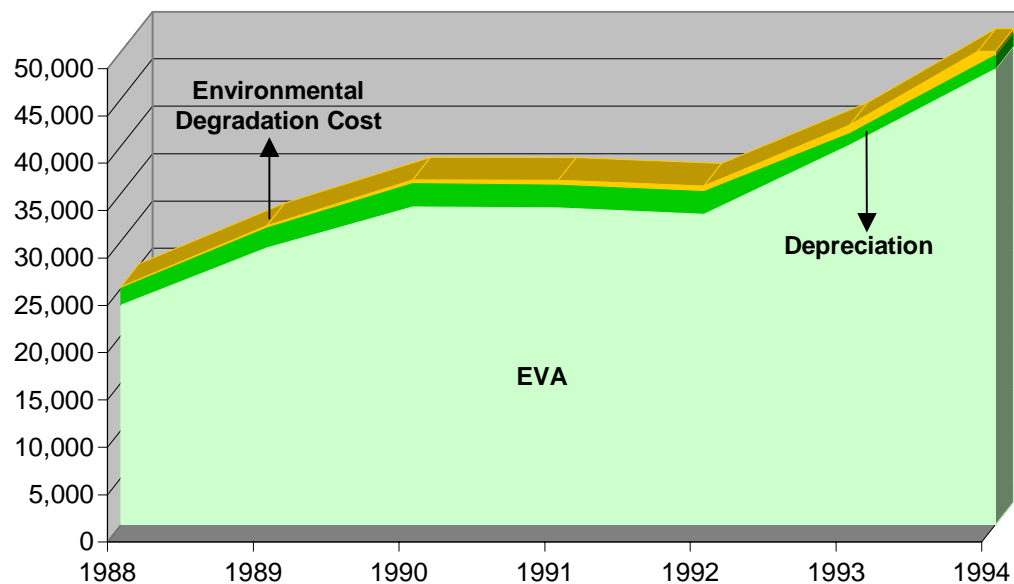
### 2.1.3.3 Environmentally Adjusted Net Value Added (EVA)

The value of environmental degradation, when deducted from the estimated net value added, yields the EVA. From 1988 to 1994, the EVA of palay industry at current prices increased from P 23.2 billion in 1988 to P 48.1 billion in 1994, registering an annual growth of 2.4 percent (Table 2.1 4). On the average, the total cost of degradation accounted for 2 percent of the estimated net value added for the seven-year period. Ideally however, the maintenance cost should be compared to the NVA of upland palay farming.

Results of the study showed that significant areas of palay farms were found to be continuously degraded primarily due to soil erosion resulting from improper and intensive cultivation practices. Although this practice is geared towards increased palay production, its corresponding effects to the environment should be given due attention owing to the adverse effects of soil erosion. In this study, as total costs of environmental degradation increased during the reference period, proper attention should be directed to this potential problem. Recent programs of the government have focused on the environmental impacts of palay farming. The Grains Enhancement Program (GEP) of the government includes, among others, an awareness campaign at sustaining the environment.

**TABLE 2.1.4 ENVIRONMENTALLY ADJUSTED NET VALUE ADDED (EVA), IN MILLION PESOS (AT CURRENT PRICES), 1988-1994**

YEAR	GVA [1]	Depreciation [2]	NVA [3] = [1] - [2]	Environmental Cost [4]	EVA [5] = [3] - [4]
1988	25,147	1,801	23,346	128	23,218
1989	31,565	2,087	29,478	228	29,250
1990	36,416	2,468	33,948	378	33,570
1991	36,373	2,415	33,968	468	33,490
1992	35,761	2,422	33,339	565	32,774
1993	42,167	1,199	40,968	848	40,120
1994	51,079	1,452	49,627	1,466	48,161



**FIGURE 2.1.2 PALAY FARMING: EVA, DEPRECIATION AND ENVIRONMENTAL COST, IN MILLION PESOS (AT CURRENT PRICES), 1988-1994**

#### 2.1.4 RECOMMENDATIONS

The following are some of the recommendations to further improve the preliminary physical and monetary estimates of environmental degradation caused by upland palay farming:

1. Expenditures of upland palay farmers on measures to control the damaging effects of palay farming activities to the environment should be included in the regular cost of production surveys of the BAS. These expenditure items should include cost for labor, materials, equipment, etc.
2. Data on the status of erosion including parameters on soil erosion rates should be updated by the BSWM. Further disaggregation by region and by type of crop should likewise be provided.
3. More comprehensive studies should be conducted on the effects of palay production to the environment particularly degradation of air, water and land. These studies may include, in particular, the effects of intensive cultivation practices and excessive application of chemicals like fertilizers, insecticides, weedicides, etc. which damage the environment. Different discharges to the environment like biochemical oxygen demand, suspended solids and nitrates should also be covered to provide updated parameters on effluents and effluent factors for air, water and land degradation.

APPENDIX TABLE 2.1.1

TOTAL UPLAND AREA SUBJECTED TO EROSION (TSEA) BY REGION, IN HECTARES,  
1988-1994

Region / Year	1988	1989	1990	1991	1992	1993	1994
<b>PHILIPPINES</b>	<b>648,217</b>	<b>674,911</b>	<b>615,121</b>	<b>661,312</b>	<b>614,973</b>	<b>637,910</b>	<b>689,815</b>
CAR	53,608	46,925	46,903	43,097	43,576	43,279	49,562
I Ilocos Region	15,148	14,482	15,006	15,147	14,803	15,054	15,421
II Cagayan Valley	15,865	16,694	16,171	15,131	15,174	13,717	17,654
III Central Luzon	9,082	10,105	10,182	9,762	9,210	9,316	10,419
IV Southern Tagalog	130,063	133,214	126,262	136,359	136,161	132,502	139,491
V Bicol Region	47,179	44,603	39,250	42,078	40,568	38,121	42,264
VI Western Visayas	171,004	167,301	142,827	174,488	170,346	179,365	194,050
VII Central Visayas	76,978	111,190	90,216	98,890	76,096	86,781	86,281
VIII Eastern Visayas	37,249	37,390	36,224	40,134	38,921	35,460	35,811
IX Western Mindanao	45,939	45,506	44,493	45,437	36,006	39,177	39,897
X Northern Mindanao	5,819	7,185	6,979	8,127	6,383	7,257	8,231
XI Southern Mindanao	12,986	13,387	13,200	13,127	10,136	11,596	11,739
XII Central Mindanao	8,233	8,238	7,212	7,111	6,150	7,498	9,571
ARMM	19,065	18,691	20,194	12,422	11,443	18,787	29,423

Note: Area of palay subject to soil erosion (TSEA) = total harvested area (AHA) x ratio of upland palay areas to total areas planted to palay (UPR)

Source: BAS  
BSWM

APPENDIX TABLE 2.1.2

## DISTRIBUTION OF TOTAL ERODED AREA AND SOIL EROSION RATES BY TYPE OF EROSION, BY REGION, 1990

Region	Percent Distribution to Total (SE <sub>j</sub> r)			Erosion Rates in MT/Hectare (SE <sub>Rj</sub> )		
	Slight Erosion	Moderate Erosion	Severe Erosion	Slight Erosion	Moderate Erosion	Severe Erosion
	SE1	SE2	SE3	SER <sub>1</sub>	SER <sub>2</sub>	SER <sub>3</sub>
CAR	30.97	44.25	24.78	6.50	17.70	59.40
I Ilocos Region	31.51	34.09	34.40	26.80	36.30	54.00
II Cagayan Valley	19.19	59.44	21.37	26.80	36.30	54.03
III Central Luzon	46.19	37.30	16.51	6.50	17.70	53.40
IV Southern Tagalog	19.46	65.20	15.34	6.50	17.70	59.40
V Bicol Region	48.89	39.30	11.81	26.80	36.30	54.00
VI Western Visayas	37.83	34.79	27.37	5.12	25.24	69.64
VII Central Visayas	29.82	44.17	26.02	1.05	6.97	26.21
VIII Eastern Visayas	50.88	24.04	25.08	5.12	25.24	69.64
IX Western Mindanao	38.82	47.02	14.16	2.54	8.10	54.72
X Northern Mindanao	38.77	36.99	24.25	4.60	17.50	61.50
XI Southern Mindanao	41.44	21.85	36.71	12.40	18.70	57.40
XII Central Mindanao	31.91	41.07	27.02	12.40	18.70	57.40
ARMM	35.13	43.84	21.03	7.47	13.40	56.06
<b>PHILIPPINES</b>	<b>36.01</b>	<b>39.89</b>	<b>24.09</b>			

Source: BSWM

APPENDIX TABLE 2.1.3

ESTIMATES OF OFF-SITE SOIL EROSION<sup>1</sup> DUE TO UPLAND PALAY FARMING, IN METRIC TONS, 1988-1994

Region / Year	1988	1989	1990	1991	1992	1993	1994
CAR	263,365	230,534	230,427	211,727	214,082	212,619	243,488
I Ilocos Region	119,353	114,102	117,144	119,346	116,632	118,608	121,505
II Cagayan Valley	121,416	127,760	123,759	115,799	116,126	104,980	135,111
III Central Luzon	33,462	37,228	37,515	35,968	33,933	34,323	38,386
IV Southern Tagalog	570,152	583,968	553,491	597,755	596,884	580,848	611,484
V Bicol Region	318,417	301,034	264,903	283,987	273,801	257,282	285,246
VI Western Visayas	1,018,580	996,524	850,749	1,039,336	1,014,661	1,068,386	1,155,856
VII Central Visayas	157,201	227,067	184,235	201,949	155,399	177,221	176,198
VIII Eastern Visayas	194,709	195,447	189,353	209,792	203,453	185,360	187,196
IX Western Mindanao	115,250	114,162	111,622	113,989	90,331	98,286	100,091
X Northern Mindanao	26,962	33,294	32,337	37,657	29,577	33,623	38,137
XI Southern Mindanao	78,688	81,121	79,988	79,547	61,419	70,266	71,133
XII Central Mindanao	44,700	44,728	39,155	38,608	33,388	40,707	51,963
ARMM	77,364	75,843	81,943	50,408	46,434	76,233	119,395
<b>PHILIPPINES</b>	<b>3,139,620</b>	<b>3,162,811</b>	<b>2,896,620</b>	<b>3,135,867</b>	<b>2,986,120</b>	<b>3,058,743</b>	<b>3,335,188</b>

<sup>1</sup> Total Soil Erosion x Sediment Delivery Ratio (SDR) at 20 percent

APPENDIX TABLE 2.1.4

## ESTIMATED NUTRIENT LOSS FROM ON-SITE EROSION (ONSE) DUE TO UPLAND PALAY FARMING, IN METRIC TONS, 1988-1994

Region / Year	1988			1989			1990			1991		
	N	P	K	N	P	K	N	P	K	N	P	K
CAR	2,318	74	42	2,029	65	37	2,028	65	37	1,863	59	34
I Ilocos Region	802	19	57	767	18	55	787	19	56	802	19	57
II Cagayan Valley	971	19	83	1,022	20	87	990	20	84	926	19	79
III Central Luzon	323	7	24	359	7	27	362	8	27	347	7	26
IV Southern Tagalog	5,040	137	1,551	5,162	140	1,588	4,893	133	1,505	5,284	143	1,626
V Bicol Region	4,305	51	280	4,070	48	265	3,581	42	233	3,840	45	250
VI Western Visayas	13,242	448	3,259	12,955	438	3,189	11,060	374	2,722	13,511	457	3,326
VII Central Visayas	2,383	31	698	3,442	45	1,008	2,793	37	818	3,062	40	897
VIII Eastern Visayas	2,952	39	865	2,963	39	868	2,871	38	841	3,180	42	931
IX Western Mindanao	1,056	32	74	1,046	32	73	1,022	31	71	1,044	32	73
X Northern Mindanao	285	3	19	352	4	24	341	4	23	398	5	27
XI Southern Mindanao	570	13	151	587	13	156	579	13	154	576	13	153
XII Central Mindanao	858	7	45	859	7	45	752	6	39	741	6	39
ARMM	1,023	12	113	1,003	12	111	1,083	13	120	666	8	74
PHILIPPINES	36,126	893	7,261	36,615	890	7,532	33,142	802	6,731	36,241	896	7,591

Region / Year	1992			1993			1994		
	N	P	K	N	P	K	N	P	K
CAR	1,884	60	34	1,871	60	34	2,143	68	39
I Ilocos Region	784	19	56	797	19	57	817	19	58
II Cagayan Valley	929	19	79	840	17	71	1,081	22	92
III Central Luzon	327	7	24	331	7	25	370	8	28
IV Southern Tagalog	5,276	143	1,624	5,135	139	1,580	5,406	147	1,663
V Bicol Region	3,702	44	241	3,478	41	226	3,857	46	251
VI Western Visayas	13,191	446	3,247	13,889	470	3,419	15,026	509	3,699
VII Central Visayas	2,356	31	690	2,687	35	787	2,671	35	782
VIII Eastern Visayas	3,084	41	903	2,810	37	823	2,838	37	831
IX Western Mindanao	827	25	58	900	28	63	917	28	64
X Northern Mindanao	312	4	21	355	4	24	403	5	27
XI Southern Mindanao	445	10	118	509	11	135	515	11	137
XII Central Mindanao	641	5	33	782	7	41	998	8	52
ARMM	614	7	68	1,008	12	111	1,578	19	174
PHILIPPINES	34,372	861	7,197	35,391	887	7,396	38,618	962	7,898

APPENDIX TABLE 2.1.5

**ESTIMATED COST OF VARIOUS SOIL AND WATER MANAGEMENT CONSERVATION MEASURES (SWCM), BY TYPE OF EROSION, IN PESOS PER HECTARE, 1988-1994**

SWCM	1988	1989	1990	1991	1992	1993	1994
Total Soil Erosion (TSEA)	648,216	674,909	614,980	661,310	614,971	637,908	689,812
SEA1	218,376	225,351	204,976	221,412	205,221	213,090	230,501
SEA2	285,833	298,647	273,436	291,958	272,792	281,504	304,564
SEA3	144,007	150,910	136,568	147,940	136,959	143,314	154,748
1. Agronomic Cover for Slight Erosion	37	63	115	133	172	249	555
2. Sloping Agricultural Land Technology (SALT) for Moderate Erosion	241	410	745	860	1,115	1,612	2,510
3. Vegetative and Engineering Measures for Severe Erosion	355	606	1,100	1,270	1,646	2,381	3,705
Total Cost	128,018	228,311	377,507	468,345	564,885	848,074	1,465,709
Slight Erosion	8,108	14,278	23,572	29,395	35,316	53,034	127,992
Moderate Erosion	68,760	122,577	203,710	251,089	304,122	453,869	764,318
Severe Erosion	51,150	91,456	150,225	187,861	225,447	341,171	573,398

Note:

<sup>1</sup> Cost of soil and water management conservation measures was obtained from the PSA Study (July 1996)

<sup>2</sup> Estimates of cost for other years were derived using an index of legislated wage rate for palay farmers were obtained from the BAS

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***Intensive Shrimp  
Aquaculture***

## 2.2.1 INTRODUCTION

### 2.2.1.1 Industry Description

The supply of fish from marine and municipal fisheries is unlikely to meet the growing demand for aquatic products. The development of other sources of marine and aquatic products is necessary to ensure the continuous supply for an ever-increasing market. As such, aquaculture plays a vital role in the economy. In 1994, aquaculture production increased its contribution to total fish production to 791,444 metric tons (MT) or 29 percent from 599,554 MT or 26.2 percent in 1988. Production was valued at ₱15,213 million in 1988 to ₱ 35,280 million in 1994. Aquaculture grew at an annual average rate of 15.34 percent during the six-year period compared with 12.9 percent for commercial fishery and 7.1 percent for municipal fishery. Aquaculture production in the Philippines continues to be dominated by milkfish (*Bangus*) culture. However, the culture of high-value species such as the prawn (*Sugpo*) has developed in the 1980's. Prawn production contributes less, quantity-wise, than milkfish production, but its high unit price results in a higher contribution in terms of value. *Sugpo* production is predominant in Region III, Region VI and Region VII.

Although there are substantial economic benefits derived from aquaculture - increased income, employment and foreign exchange earnings, it has a significant impact on the environment. It utilizes resources usually meant for other economic activities and causes changes in the environment. It can alter natural food chains and natural habitats devoted to it. Therefore, it is essential that the effects of aquaculture, particularly prawn production on the environment be assessed.

### 2.2.1.2 Scope and Limitations of the Study

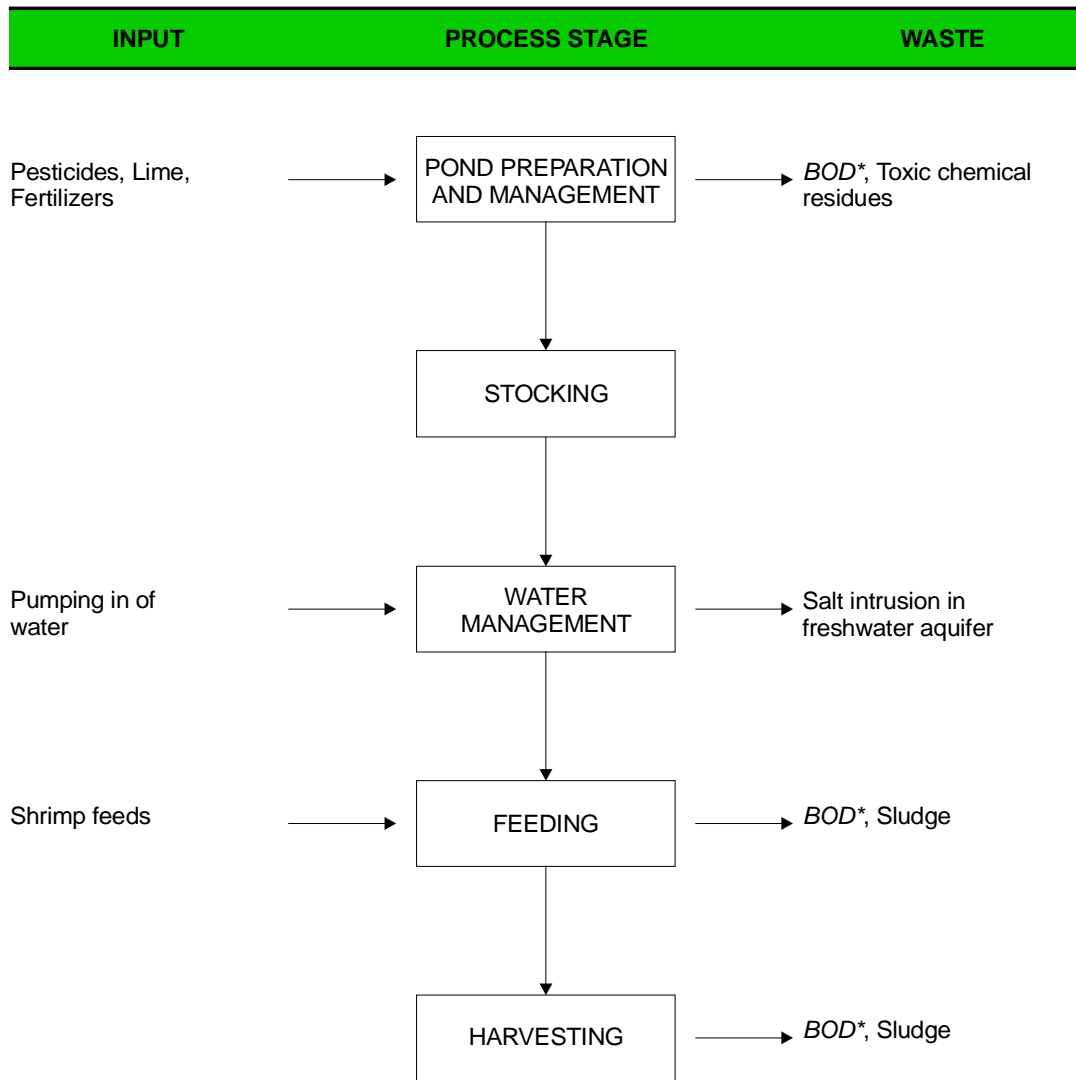
This study focuses on the measurement of environmental degradation brought about by the intensive culture of shrimps, expressed in physical and monetary terms. The monetary estimates used the maintenance cost approach, which accounts for the expenditure required to control or abate the environmental degradation caused by shrimp culture, where, in this study, was limited to the use of biofilters.

Intensive culture of shrimps is marked by increased inputs resulting to a high level of nutrient and organic loads per unit area. Intensive culture of shrimps, therefore, poses greater threat to the environment, particularly, land and water resources than extensive or semi-extensive types of culture. This study, however, only considered environmental degradation to the water media due to data constraints. Water effluents covered include phosphates, nitrite, nitrate, ammonia, BOD, total suspended solids (TSS), total solids and settleable solids.

### 2.2.1.3 Production Process and Pollutants Generated

Three types of shrimp culture methods are commonly practiced in the Philippines: extensive, semi-intensive and intensive shrimp culture. The differences between these types are based on the type of feeds, water management, stocking density, culture period, pond size and pond development costs, survival, and average production per year. Details and comparison of the culture types are included in Appendix Table 2.2.1. This study however, concentrated only on intensive shrimp culture.

The production process involved in shrimp culture is best illustrated in Figure 2.2.1. It includes pond preparation and management, stocking, water management, feeding and harvesting. Also shown in Figure 2.2.1 are the inputs to each production process and the corresponding wastes generated from the processes.



Source:  
BFAR

\* Pollutant estimated in this study, physical and monetary

FIGURE 2.2.1 PRODUCTION PROCESS OF INTENSIVE SHRIMP AQUACULTURE

## 2.2.1.4 Effects to Environmental Media

### 2.2.1.4.1 To Water

- Use of Feeds and Fertilizers

Pollution from intensive shrimp aquaculture comes from the waste and organic matter derived largely from the input of feeds and fertilizer. Nutrient and organic wastes consist of solid matter (uneaten food, feces and phytoplankton) and dissolved metabolites (ammonia, urea and CO<sub>2</sub>). The major impact of feeds and feeding techniques consist of hypernutrification, the most important pollutant being the nutrients which normally limit primary production - inorganic phosphate and nitrogen. The amount of feed wasted also has an important role in total waste loading. Because feeds settle directly to the pond bottom, feed wastage has a significant effect on sediment quality.

Water effluents from shrimp culture consist of BOD, phosphates, nitrogen in the form of nitrites and nitrates, ammonia, total solids, suspended solids and total settleable solids. These pollutants are included in this study.

- Use of Chemicals and Chemotherapeutants

With the expansion of intensive shrimp aquaculture, chemical use has become an increasing part of the management techniques. Chemicals are used in intensive fishponds as medicaments for the treatment and prevention of diseases and, to some extent, improve water quality. These are also used as feed additives and disinfectant. It has been reported that extensive use of antibiotics in shrimps has resulted in resistant strains of pathogenic bacteria in the pond. Larval shrimps that were given antibiotics were shown to be sensitive to external stress and wild pathogens once they leave the hatcheries. This may result in mass mortality. Shrimp brooders consuming antibiotics over a long period of time were found to have lower egg quality. However, there is not enough information on the types and the exact amounts of chemicals used in the country because some shrimp farmers are hesitant to disclose such information. Water effluents and chemicals used in fishponds settle in the pond bottom and may have several impacts in the receiving waters. Among these are:

1. Reduced dissolved oxygen because of the breakdown of organic matter and other waste materials.
2. Eutrophication of receiving waters that may result in algal blooms.
3. Increased sedimentation due to organic matter, leading to changes in productivity and benthic community structure (Phillips, 1993).

The impacts, however, depend on the capacity of the receiving waters to assimilate the waste materials and chemicals. At present, the treatment of effluent discharges from shrimp ponds are still in the early stages of development.

The expansion of intensive shrimp aquaculture also affect the mangrove areas. These areas are often converted to fishponds for shrimp culture thus the significant decline in mangrove areas over the years. Clearing of mangrove areas demolishes the breeding habitats for fry and fingerlings of important species and the removal of coastal protection from erosion by wind and water. However, in this study there is no estimate of degradation to land.

Aquaculture development may result in saltwater intrusion and salinization of freshwater aquifers. Salinization results in the degradation of domestic and agricultural water supply which makes it unfit for domestic and agricultural use (Aypa, 1997). Moreover, overpumping of freshwater from underground for fishponds may cause sinking of the soil surface and intrusion of saltwater to freshwater aquifers. Due to data constraints, however, no estimation for these effects both to land and water were included in this study.

## 2.2.2 SOURCES AND METHODS

### **2.2.2.1 Data Sources**

The data on volume of fish and prawn production as well as the area of intensive shrimp fishponds were taken from the BAS. The Bureau of Fisheries and Aquatic Resources (BFAR), on the other hand, provided data on the cost of using biofilters in shrimp fishponds.

A study by the Institute of Aquaculture of the University of the Philippines at Visayas (UPV) provides the data on pollution load coefficients per effluent used in the estimation of the volume of pollutants in physical terms. This study measured the extent of the contribution of aquaculture effluents on the pollution of Imbang River, Silay, Negros Occidental. Pollution loads from six aquaculture ponds discharging into the river were taken, for a period of two years (May 1993 to February 1995).

In terms of the monetary estimates, the data on the GVA for aquaculture were obtained from the National Accounts of the Philippines compiled by the NSCB.

### **2.2.2.2 Estimation Methodology**

#### **2.2.2.2.1 Physical Estimation**

Water quality and quantity are critical values in shrimp culture. Water should be free from pollution and should be within the required temperature and salinity. Hence, there is a need for a regular water change and discharge throughout the culture period. Appendix Table 2.2.2 summarizes the frequency of water change required and the volume of water discharged.

#### **2.2.2.2.2 Monetary Estimation**

At present, there is little information on pollution control devices or wastewater treatments used in intensive shrimp culture. However, there is an ongoing project being conducted by the Aquaculture Division of the BFAR on the use of Biofilters (mussels and seaweeds) to treat the water discharged from the ponds during water exchanges.

Biofilters are living organisms that feed on suspended solid particles and impurities in liquids. In this study, the water reservoir area, or 10 percent of the total area devoted to shrimp aquaculture is used for waste treatment. Mussels and seaweeds are put in place alternately using the line method (nylon ropes are placed in the water where the mussels and seaweeds will cling). The water treated in this area came from the pond during water exchange. The biofilters will feed on the excess nutrients and suspended particles in the water, thereby eliminating and filtering effluent discharges. This study, however, is still ongoing. There are no definite results yet regarding its efficiency and effectiveness. For lack of information and parameters to estimate the cost of environmental degradation, the parameters used in the study of the BFAR were applied in this estimation.

To compute for the volume of mussels (biofilter) per wastewater pond (ha.), it was assumed that one mussel can filter 25 liters of water in 24 hours. The total volume of water needed (in liters) was derived by multiplying the volume of water per flushing by the frequency of water change. The number of mussels required for a pond was calculated as follows:

The derived figure is divided by 25 liters, then divided by the number of days every flushing. Based on the above computation for the number of mussels required, the maximum number of mussels is taken. Hence, the estimate of 16,800 mussels needed to treat the total volume of water discharged per hectare is used. To convert this figure to kilograms, the number is divided by the average number of mussels per kilo. Hence:

16,800 mussels / 20 mussels. (avg. no. of mussels/kilo) = 840 kg of mussels

To compute for the volume of seaweeds (biofilter) per wastewater pond, it was assumed that 100 grams of seaweeds are placed one meter apart in the pond, therefore, 400 gm. or .40 kg of seaweed is needed per square meter, or a total of 400 kg. of seaweed is needed, assuming that the area of wastewater pond is 1,000 square meter. To get the total amount of seaweeds needed for the total wastewater pond area, it was assumed that 10 percent of the total area occupied by fishponds is reserved for wastewater treatment.

Finally, to get the value of the mussels and seaweeds needed, the number of kilos of mussels and seaweeds required (840 kg. for mussels; 400 kg. for seaweeds) were multiplied by their average price per kilo (see Appendix Table 2.2.6).

## 2.2.3 RESULTS

### 2.2.3.1 Physical Estimates

Table 2.2.1 shows the trend in the volume of pollutant loads over the period 1988 - 1994. The highest level of pollutant came from Total Solids (TS) which are mainly composed of uneaten food, feces and phytoplankton. Total TS discharges reached 1.21 billion MT in 1988 to 1.64 billion MT in 1994. This was followed by TSS with 11.9 million MT in 1988 to 16.2 million MT in 1994.

**TABLE 2.2.1 TOTAL EFFLUENT LOAD<sup>1</sup>, IN THOUSAND METRIC TONS, 1988-1994**

YEAR	BOD	PO <sub>4</sub> -P	NH <sub>3</sub> -N	NO <sub>2</sub> -N	NO <sub>3</sub> -N	TS	TSS	SS
1988-1991	1,022.4	7.8	6.5	1.3	2.9	1,206,269.4	11,878.1	7.8
1992	874.8	6.6	5.6	1.1	2.5	1,032,045.2	10,162.5	6.7
1993	830.8	6.4	5.3	1.1	1.2	980,176.9	9,651.8	6.3
1994	1,393.2	10.6	8.9	0.9	2.0	1,643,824.6	16,186.7	10.6

<sup>1</sup> Pollution Load (MT/Ha) x 10 percent of Total hectares x no. of cropping (2)

Among the nutrient discharges, phosphates (PO<sub>4</sub>-P) accounted for the bulk of pollution. It amounted to 7,800 MT in 1988 and 10,600 MT in 1994. Nitrites (NO<sub>2</sub>-N) generated the least pollution, with 1,300 MT in 1988 and further decreasing to 900 MT in 1994.

### 2.2.3.2 Monetary Estimates

The estimated environmental degradation cost of intensive shrimp aquaculture increased from P15.3 million in 1988 to P 25.8 million in 1994. The highest expenditure of 29 million was incurred in 1991. This was due to the steep rise in the price of mussels for that year. The degradation cost declined in 1992 and 1993 then increased to P 25.8 million in 1994. Table 2.2.2 summarizes the environmental cost of intensive shrimp aquaculture.

**TABLE 2.2.2 TOTAL ENVIRONMENTAL COST USING BIOFILTERS, IN THOUSAND PESOS, 1988-1994**

Year	Cost of Biofilters (Per Ha/Year)	10 Percent of Total Area of Intensive Shrimp Fishponds (Ha)	Environmental Cost
1988	16.828	907	15,263
1989	17.538	907	15,907
1990	20.972	907	19,022
1991	31.914	907	28,946
1992	26.560	776	20,611
1993	19.790	737	14,585
1994	20.846	1,236	25,766

**2.2.3.3 Environmentally Adjusted Net Value Added (EVA)**

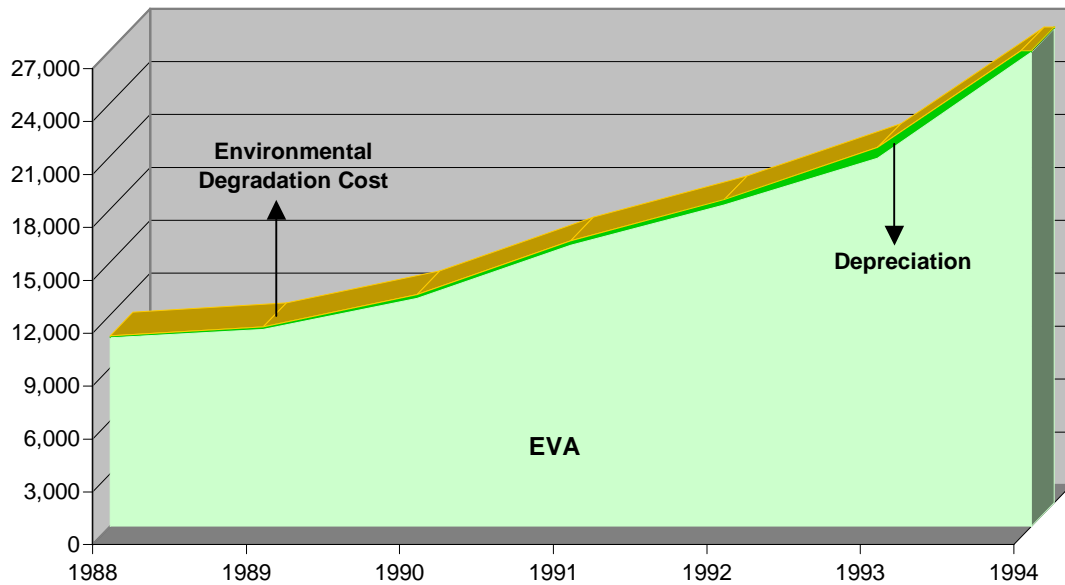
For the period 1988-1994, NVA increased from P 10.73 billion in 1988 to P 26.93 billion in 1994. This translates to an annual average increase of 16.8 percent over the reference period (Table 2.2.3)

The EVA likewise increased from P 10.72 billion in 1988 to P 26.90 billion in 1994 (Figure 2.2.2).

Results show that the pollution generated by the intensive culture of shrimp intensified over the accounting period, as the environmental cost increased each year. This also shows that the environmental cost is considerable, in view of the rapid intensification and expansion of the industry.

**TABLE 2.2.3 ENVIRONMENTALLY ADJUSTED NET VALUE ADDED (EVA), IN MILLION PESOS (AT CURRENT PRICES), 1988-1994**

YEAR	GVA [1]	DEPRECIATION [2]	NVA [3]=[1]-[2]	ENVIRONMENTAL COST [4]	EVA [5]=[3]-[4]
1988	10,822	88	10,734	15	10,719
1989	11,335	133	11,202	16	11,186
1990	13,160	185	12,975	19	12,956
1991	16,215	215	16,000	29	15,971
1992	18,562	294	18,268	21	18,247
1993	21,512	601	20,911	15	20,896
1994	27,384	454	26,930	26	26,904



**FIGURE 2.2.2 INTENSIVE SHRIMP AQUACULTURE: EVA, DEPRECIATION AND ENVIRONMENTAL DEGRADATION COST, IN MILLION PESOS (AT CURRENT PRICES), 1988-1994**

#### 2.2.4 RECOMMENDATIONS

The lack of information and adequate research regarding pollution from intensive shrimp aquaculture prevented this study in coming up with definite conclusions. Regular assessment and monitoring of environmental changes associated with aquaculture development should be implemented by concerned agencies to properly account for the pollution in the industry.

There is also a need to develop regulation standards for aquaculture regarding farm design, siting and system management to promote the economic growth of the industry and at the same time, ensure that the environment is conserved and protected.

Lastly, the conduct of regular activities such as cost of production survey (including environmental expenditures) and aquaculture survey, in general, should be done by BFAR or BAS. These data will provide vital inputs to the proper accounting of environmental damages due to intensive shrimp aquaculture.

## APPENDIX 2.2.1

### TYPES OF SHRIMP AQUACULTURE PRACTICES

- A. **Extensive** - This type of culture is done in relatively bigger ponds with size ranging from 2 to 20 hectares. It relies mainly on natural food and tidal fluctuation for water exchange. Fertilizers may also be added. Stocking density is from 1,000 to 10,000 per hectare. Yearly production ranges from 100 to 500 kg/ha/year. Low input and low yields characterize this type. Extensive culture of shrimp has no significant pollution loading of organic matter to the ecosystem.
- B. **Semi – Intensive** - The progression from extensive to semi-intensive culture is marked by increased inputs. Supplementary feeding of pellets, trash fish, etc., are given only if natural food is not sufficient. Water pumps are used along with tidal water for water exchange. Stocking density is from 10,000 to 50,000 per hectare. Pond size ranges from 1 to 5 hectares. Production is relatively higher than in an extensive culture, at 500 to 4,000 kg /ha/yr.
- C. **Intensive** - This type of culture is totally independent from nature. It relies completely on formulated diets in pellet form. It has a high stocking rate of 50,000 to 300,000 per hectare. Its production reaches 5 to 15,000 kg/ha/year. Water exchange is by means of pumps and use of paddlewheels. Pond size is smallest at 1,000 sq. meters to 1 hectare. The degree of intensification is defined according to feeding practice, accompanied by increased amount of labor, capital and mechanization.

APPENDIX TABLE 2.2.2

## COST OF BIOFILTERS PER WASTE TREATMENT POND

	1988	1989	1990	1991	1992	1993	1994
<u>MUSSEL</u>							
₱/kilo	9.00	9.28	11.08	17.13	13.60	9.71	10.51
Amount / ha.	7,560.00	7,795.00	9,307.00	14,389.00	11,424.00	8,156.00	8,828.00
1. Amount / ha. x No. of cropping	15,120.00	15,590.00	18,614.00	28,778.00	22,848.00	16,313.00	17,657.00
<u>SEAWEEEDS</u>							
₱/kilo	1.97	2.25	2.73	3.66	4.37	4.06	3.69
Amount / ha.	788.00	900.00	1,092.00	1,464.00	1,748.00	1,624.00	1,476.00
2. Amount / ha. x No. of cropping	1,576.00	1,800.00	2,184.00	2,928.00	3,496.00	3,248.00	2,952.00
3. Subtotal (1+2)	16,696.00	17,390.00	20,798.00	31,706.00	26,344.00	19,561.00	20,608.00
4. Labor Cost	132.00	148.00	174.00	208.00	216.00	230.00	238.00
5. TOTAL (3+4)	16,828	17,538.00	20,972.00	31,914.00	26,560.00	19,790.00	20,846.00

APPENDIX TABLE 2.2.3

## FREQUENCY OF WATER CHANGE AND VOLUME OF WATER DISCHARGED, IN CUBIC METERS PER HECTARE

DAYS OF CULTURE	FREQUENCY OF WATER EXCHANGE	PERCENT OF WATER CHANGE	VOLUME OF WATER DISCHARGED PER HECTARE (cm <sup>3</sup> )
1-30 days	Once (every 30 days)	45	3,150
31-60 days	2x (every 15 days)	45	6,300
61-90 days	4x (every 7.5 days)	45	12,600
91-harvest	2x (every 15 days)	45	6,300
TOTAL			28,350

To compute for the volume of water discharged (in cm<sup>3</sup>.ha), the total volume of water per hectare is derived:

One hectare of fishpond is equivalent to 10,000 m<sup>2</sup> with a pond depth of 0.7 meters.

Hence, the total volume is equivalent to 7000 m<sup>3</sup>:

$$\begin{aligned} \text{Volume of water/ha} &= 10,000 \text{ m}^2 \times 0.7 \text{ m} \\ &= 7,000 \text{ cm}^3 \end{aligned}$$

Hence, the volume of water discharged for day 1-30 is equal to the Total volume of water per hectare x percent of water change

$$\begin{aligned} &= 7,000 \text{ cm}^3 \times 45 \text{ percent} \\ &= 3,150 \text{ cm}^3 \end{aligned}$$

APPENDIX TABLE 2.2.4

## WATER POLLUTANTS IN AN INTENSIVE SHRIMP POND

POLLUTANTS	AVERAGE POLLUTION LOAD* (Mg/liter)	POLLUTION LOAD (PL)	
		(kg/ha/cropping)	(MT/ha)
BOD	19.880	563,598	563.6
PO <sub>4</sub> -P	0.151	4,292	4.3
NH <sub>3</sub> -N	0.127	3,589	3.6
NO <sub>2</sub> -N	0.002	71	0.1
NO <sub>3</sub> -N	0.056	1.59	1.6
TS	23,456.000	664,977.60	664,977.6
SS	0.151	4,28	4.3
TSS	230.970	6,458,000	6,458.0

\*Source: Gonzales, G. A. et. al. " River Pollution: An Investigation of the Influence of Aquaculture and other Agri-industrial Effluents on a Commercial Waterway", Institute of Aquaculture, College of Fisheries, UP Visayas.

To compute the pollution load by pollutant expressed in kg/ha, the volume of water discharged per hectare (28,350 cm<sup>3</sup>) was multiplied by the respective average pollutant load as shown in the equation below:

$$\text{Pollution Load (PL)} = \text{Total volume of water discharged per hectare} \times \text{average pollution load}$$

$$\begin{aligned} \text{Example: pollution load of BOD} &= 28,350 \times 19,880 \\ &= 563,598 \text{ kg} \end{aligned}$$

To express this in MT/ha, the derived figure is divided by 1000

$$\text{Hence: } 563,598 \text{ kg} \div 1000 \text{ is equal to } 563.6 \text{ kg}$$

In the estimation of total pollution load (TPL) (Table 2.2.1) each pollutant load (expressed in MT/Ha) was multiplied by 10 percent the total area of intensive brackish shrimp fishpond for the year multiplied by the number of croppings per year, as shown in the following equation:

$$\text{TPL} = \text{pollution load} \times \text{area} \times \text{no of cropping /year}$$

where:

$$\text{No. of cropping per year} = 2$$

Example:

$$\begin{aligned} \text{TPL}_{\text{BOD1988}} &= 563.6 \times 907 \times 2 \\ &= 1,022.4 \text{ MT} \end{aligned}$$

APPENDIX TABLE 2.2.5

**AREA OF INTENSIVE PRAWN FISHPONDS AND WATER RESEVOIR, IN HECTARES,  
1988-1994**

Area	1988	1989	1990	1991	1992	1993	1994
Shrimp Fishponds	9,065	9,065	9,065	9,065	7,755	7,371	12,361
Water Reservoir area (10%)	907	907	907	907	776	737	1,236

Source: BAS (benchmark data for 1992)

APPENDIX TABLE 2.2.6

**ESTIMATION OF THE REQUIRED NUMBER OF MUSSELS**

NO. OF DAYS OF CULTURE	WATER FLUSHING		REQUIRED NUMBER OF MUSSELS
	Frequency	Total Volume (in Liters)	
1-30 days	Once (every 30 days)	3,150	4,200
31-60 days	2x (every 15 days)	6,300	8,400
61-90 days	4x (every 7.5 days)	12,600	16,800
91-harvest	2x (every 15 days)	6,300	8,400
TOTAL		28,350	

For culture day 1 – 30, the required number of mussels is computed as follows:

a) total volume in  $\text{cm}^3$  is converted into liters, thus,

$$\text{no. of mussels} = \text{volume (in liters/25liters)} \div 30 \text{ days}$$

$$= 43,150 \text{ cm}^3 \times 1000 \div 25 \div 30$$

$$= 4,200 \text{ mussels}$$

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# ***Hog Raising***

### 2.3.1 INTRODUCTION

#### 2.3.1.1 Industry Description

From 1988 to 1994, the hog industry contributed 77 percent to the total GVA of the livestock sector. This accounted for 10 percent of the combined GVA in Agriculture, Fishery and Forestry sectors. At current prices, the GVA of the industry grew at a rate of 11.4 percent annually from ₱14.2 million in 1988 to ₱34.6 million in 1994.

Results of the nationwide survey of the PSA showed that commercial hog farms employed about 12,000 workers, employing 7 full-time workers per 1,000 full-time employees in all industries. The hog industry is also known for its environmental impact. The hog industry is a highly pollutive industry and ranked second to food processing in terms of BOD discharges. The sector generates around 1,000 metric tons of BOD per day and accounts for 27 percent of the total BOD discharges of 10 most pollutive industries in the Philippines (Montgomery, 1992).

#### 2.3.1.2 Scope and Limitations of the Study

This study covers the accounting in physical and monetary terms of the environmental degradation caused by the hog industry for the period 1988 to 1994. The study covered only pollutants to water, namely: BOD<sub>5</sub>, SS, Nitrogen (N) and Phosphorous (P). Pollutants to land and air were not considered due to the unavailability of required data and parameters.

The monetary estimates of environmental degradation covered only the cost of reducing BOD loads in wastewater discharges to effluent standards level. In practice, wastewater treatment plants (WTP's) in the industry are designed primarily for controlling BOD discharges. Use of separate treatment plants for other pollutants is not commonly practiced.

#### 2.3.1.3 Production Process and Pollutants Generated

There are six (6) stages in hog raising, namely: breeding, gestation, farrowing, weaning, starting, growing, and, fattening and finishing. In each stage, wastes generated include feed spills, manure, urine, wastewater, placentas and mortalities. These wastes if not controlled or properly disposed can cause pollution to the environment (see Figure 2.3.1).

Wastes generated from hog farms affect the quality of the environment. These can either lower or upgrade the quality of the receiving environmental media depending on the volume of waste generated and where they are discharged. The organic wastes from the industry can improve the productivity of the agricultural land when used as fertilizer. However, when these discharges exceed the assimilative capacity of the receiving environmental media (air, water and land), it can lower the quality of the media. Indiscriminate discharge of organic wastes into water bodies also causes major environmental problems. These wastes which contain phosphorous (P) and nitrogen (N) facilitate algal bloom. Excessive proliferation of algae significantly contributes to the clogging of sewage systems and depletion of dissolved oxygen in receiving water bodies. The wastes can also alter the natural physico-chemical properties (i.e., pH, turbidity and hardness) of the receiving water bodies and may cause detrimental effects on the living organisms in the water ecosystems.

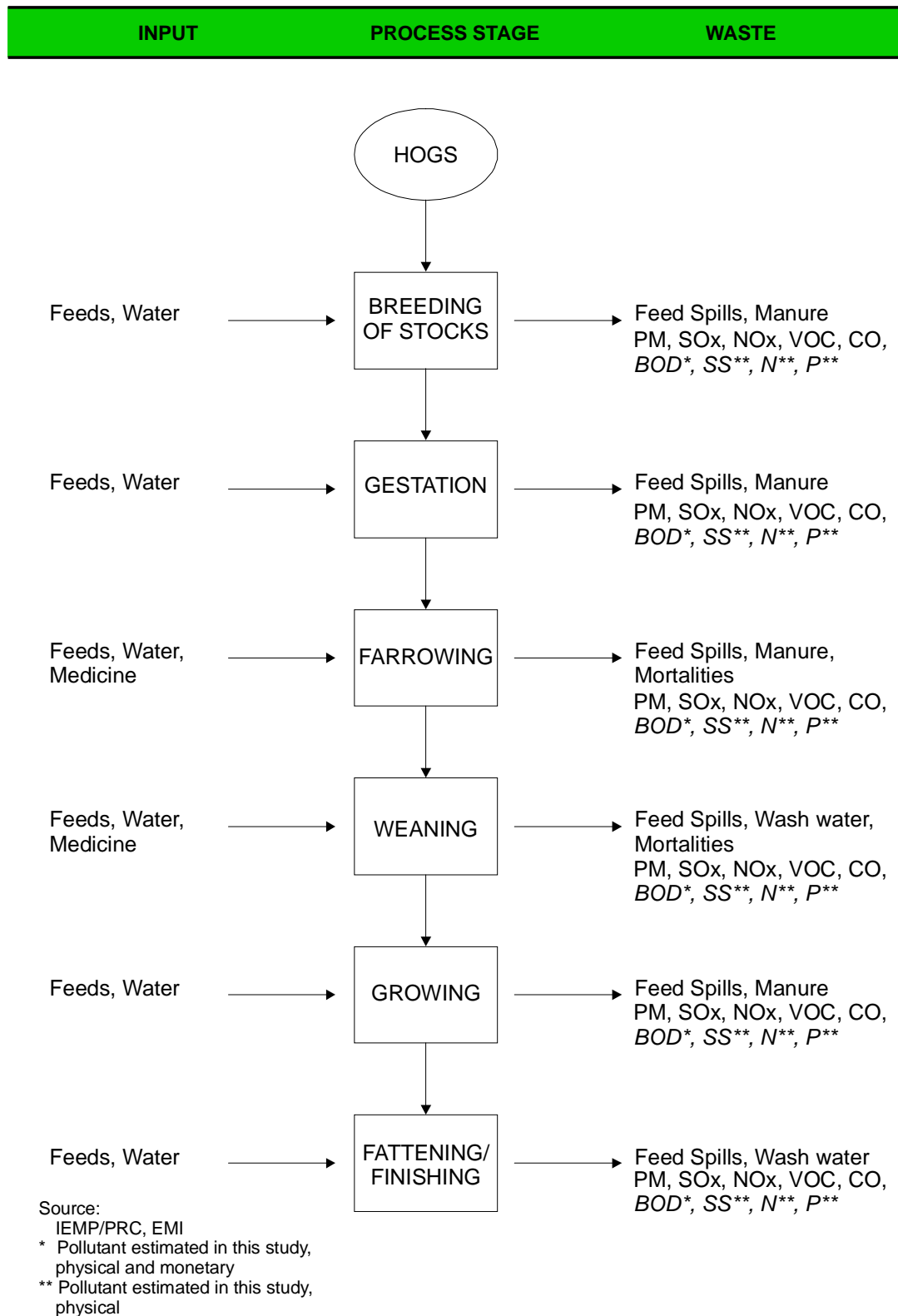


FIGURE 2.3.1 HOG RAISING PRODUCTION PROCESS

#### **2.3.1.4 Treatment Process**

The common WTP in hog industry can be divided into two stages namely: the primary or physical treatment and the secondary or biological treatment. Primary or physical treatment involves sedimentation, filtration, solid-liquid separation which are done manually or by the use of pit and settling/septic tank. This treatment has about 30 percent BOD removal efficiency. Secondary or biological treatment involves aerobic and anaerobic oxidation. This process can be done by the use of lagoons or oxidation ponds. The combination of physical treatment and secondary treatment has 90-95 percent BOD removal efficiency.

Reducing BOD and SS loads in wastewater to the effluent standard level can be achieved by both the primary and secondary treatment process, while reduction of N and P requires tertiary treatment which is more costly compared to other two types of treatments (PSA, 1994). In practice, WTP's in the industry are designed primarily for controlling BOD discharges.

#### **2.3.1.5 Assumptions**

The study, owing to the lack of data/information or parameters, employed several assumptions in coming up with the physical and monetary estimates for the environmental degradation caused by the hog industry. These are:

- The average of the quarterly inventory of hogs was assumed to be equal to the total number of hogs alive throughout the reference year.
- The volume of waste discharged and the degree of degradation to the environment were assumed to be directly proportional. This was based on the premise that the greater the amount of discharges to the environment, the more serious are the effects on the environment in consideration of the absorptive capacity of the environment.
- Backyard hog farms' pollution reduction was assumed to be zero.
- Environmental Protection Cost (EPC) for the industry was limited to the cost of reducing BOD<sub>5</sub> discharges to effluent standard level.

### **2.3.2 SOURCES AND METHODS**

#### **2.3.2.1 Data Sources**

The data on annual inventories of hogs by farm type (backyard farms and commercial farms) were obtained from the available data on quarterly inventory of the BAS. The distribution of the total hogs by sow level in commercial piggeries was based on the 1995 Survey of the Philippine Major Hog/Sow/Fattener Suppliers conducted by the PSA. This was used to estimate the AnCC and AOMC of WTP (see Appendix Table 2.3.1)

Controlled BOD discharges were calculated based on the assumption that commercial hog farms had BOD removal efficiency of 59.4 percent in 1993. This was based on the study of Orbeta and Calara in 1995. This ratio was assumed to be constant over the period 1988 to 1994.

The pollution load factors that were adopted are the results of studies conducted by the Industrial and Environmental Management Program (IEMP). Other parameters were taken from the study on water pollution undertaken by the Water Pollution and Quality Division of the Metropolitan Water and Sewerage System (MWSS).

The basic input data for the estimation of the cost per metric ton of BOD reduction by WTP capacity were taken from the 1992 report of the Industrial Efficiency and Pollution Control Program (IEPC). The unit capital costs of WTP by capacity were interpolated from the estimated engineering cost of WTP (Appendix Table 2.3.1). One limitation of the cost estimate, however, was the exclusion of the cost of land to the total estimated costs.

The data on GVA, NVA, GDP and Implicit Price Index (IPIN) of private construction were taken from the National Accounts of the Philippines, a publication of the Economic and Social Statistics Office (ESSO), NSCB.

### 2.3.2.2 Estimation Methodology

#### 2.3.2.2.1 Physical Estimation

The amount of pollutants generated by the hog industry was computed by multiplying the Pollution Load Factor (PLF, see Appendix 2.3.2) by the total number of hog raised for the period. The reported inventory of hogs from BAS was adjusted with an undercoverage ratio of 20 percent. Pollutants were estimated separately for commercial and backyard farms.

For example, the estimation for BOD<sub>5</sub> was as follows:

$$\begin{aligned} \text{BOD}_{5\text{com}} &= H_{\text{com}} \times \text{PLF}_{\text{BOD}_5} \\ \text{BOD}_{5\text{byf}} &= H_{\text{byf}} \times \text{PLF}_{\text{BOD}_5} \\ \text{BOD}_{5\text{tot}} &= \text{BOD}_{5\text{com}} + \text{BOD}_{5\text{byf}} \end{aligned}$$

where :

$$\begin{aligned} \text{BOD}_{5\text{com}} &= \text{BOD}_5 \text{ pollutants generated by commercial farms} \\ \text{BOD}_{5\text{byf}} &= \text{BOD}_5 \text{ pollutants discharged by backyard farms} \\ H_{\text{com}} &= \text{number of hogs raised by commercial farms for the period} \\ H_{\text{byf}} &= \text{number of hogs raised by backyard farms for the period} \\ \text{PLF}_{\text{BOD}_5} &= \text{Pollution Load Factor of BOD}_5 \end{aligned}$$

The same methodology was used for other pollutants: SS, N, and P using corresponding PLF factors. See table below for the effluent factors used in the estimation.

These pollutants were classified as controlled and uncontrolled. Controlled pollutants are total pollutant discharges controlled through treatment of wastewater generated by the industry while uncontrolled pollutants are those that have escaped the WPT and those that do not pass through any environmental control devices and are discharged freely into the environment, particularly water bodies. The controlled pollutants were estimated by multiplying the average efficiency of WTP's by the total amount of pollutants generated by the commercial hog farms. Only commercial hog farms have WTP's. For backyard piggeries (20 heads and below), pollution control was assumed to be zero. Uncontrolled BOD<sub>5</sub> consists of those discharged from backyard farms and the uncontrolled BOD<sub>5</sub> discharges of the commercial hog farms.

$$\begin{aligned} \text{BOD}_5(\text{cont}) &= 59.4 \text{ percent of } \text{BOD}_{5\text{com}} \\ \text{BOD}_5(\text{uncont}) &= \text{BOD}_5(\text{tot}) - \text{BOD}_5(\text{cont}), \text{ or} \\ &= \text{BOD}_5(\text{uncont}) + \text{BOD}_5 \text{ byf} \end{aligned}$$

where:

$$\begin{aligned} \text{BOD}_5(\text{cont}) &= \text{controlled BOD}_5 \text{ discharges} \\ \text{BOD}_5(\text{uncont}) &= \text{uncontrolled BOD}_5 \text{ discharges of hog farms} \\ &= \text{uncontrolled emission of commercial hog farms} \end{aligned}$$

### 2.3.2.2.2 Monetary Estimation

In computing for the EPC, the cost of controlling BOD<sub>5</sub> (EPE) and the required cost of controlling the BOD<sub>5</sub> that goes into the environment (REPE) should be determined.

The EPE represents the actual cost of controlling BOD<sub>5</sub> (AnCC + AOMC) per metric ton of effluent. This is computed by multiplying the amount of BOD<sub>5</sub> discharged by the cost of controlling one metric ton of the pollutant. This is represented below as:

$$\text{EPE} = \text{BOD}_{5 \text{ cont}} \times \text{AC\&MOC}_{\text{wpt}}$$

The REPE, on the other hand, would represent the required or incremental cost of controlling BOD<sub>5</sub>. This is computed by multiplying the amount of uncontrolled BOD<sub>5</sub> by 95%, the average effluent standard prescribed by the DENR. The figure derived from this would represent the amount of effluents that goes directly to the environment, the 5% being assumed to have been absorbed or assimilated by the environment. This figure is then multiplied by the cost of controlling BOD<sub>5</sub> (AnCC + AOMC) per metric ton of effluent, or:

$$\text{REPE} = \text{BOD}_{5 \text{ uncont}} \times .95 \times \text{AC\&MOC}_{\text{wpt}}$$

The total value of pollutants generated by the hog industry is then computed by summing up the EPE and the REPE. As such, EPC is computed as:

$$\text{EPC} = \text{EPE} + \text{REPE}$$

## 2.3.3 RESULTS

### 2.3.3.1 Physical Estimates

In 1994, the hog industry discharged an estimated 1,117 MT of BOD per day. This translates to approximately 470 thousand MT for the year (see Table 2.3.1). Over the period 1988-1994, the total discharges exhibited an increasing trend, resulting from increasing population of hogs raised during the period. The BOD<sub>5</sub> discharges rose from 427,708 metric tons in 1988 to 470,283 metric tons in 1994. The amount of SS generated by the sector was also significant at 482,973 MT in 1994 (Table 2.3.2). Other water pollutants generated are 75,573 MT of Nitrogen and 12,882 MT of Phosphorous.

Backyard farms generated more pollutants than the commercial farms. In 1994, BOD<sub>5</sub> generated by backyard farms was estimated at 364,888 MT while that of commercial farms was estimated at 105,395 MT. However, BOD<sub>5</sub> generated by commercial farms increased at a much higher rate than those generated by the backyard farms. From 1988 to 1994, the pollution generated by the commercial farms increased by 29.7 percent while that of the backyard farms increased only by 5.3 percent.

**TABLE 2.3.1 ESTIMATED CONTROLLED AND UNCONTROLLED BOD<sub>5</sub> DISCHARGES, BY TYPE OF FARM, 1988-1994**

YEAR	BOD Discharges by Type of Farms			BOD Discharges (MT)		
	Backyard	Commercial	Total	Controlled	Uncontrolled	Total
1988	346,430	81,278	427,708	48,279	379,429	427,708
1989	361,184	82,357	443,542	48,920	394,621	443,542
1990	360,757	89,086	449,843	52,917	396,926	449,843
1991	352,382	99,140	451,523	58,889	392,633	451,523
1992	362,142	86,103	448,245	51,145	397,100	448,245
1993	354,615	91,421	446,036	54,304	391,732	446,036
1994	364,888	105,395	470,283	62,605	407,679	470,283

Assumptions:

1. About 59.4 percent of BOD discharges of commercial piggeries were regulated based on the study of Orbeta et. al. (1995); this was assumed to be constant for 1988 to 1994.
2. Pollution reduction in backyard piggeries (20 heads and below) was assumed to be zero

**TABLE 2.3.2 ESTIMATED WASTEWATER POLLUTION LOADS, BY TYPE OF FARM, IN METRIC TONS, 1988-1994**

Total	Backyard Hog Farms			Commercial Hog Farms			Total		
	SS	N	P	SS	N	P	SS	N	P
1988	355,922	55,682	9,491	83,354	13,052	2,225	439,276	68,734	11,716
1989	371,080	58,053	9,895	84,461	13,225	2,254	455,541	71,279	12,150
1990	370,641	57,985	9,884	91,362	14,306	2,438	462,003	72,291	12,322
1991	362,036	56,639	9,654	101,673	15,920	2,714	463,710	72,559	12,368
1992	372,064	58,207	9,922	88,302	13,827	2,357	460,366	72,034	12,279
1993	364,331	56,998	9,715	93,756	14,681	2,502	458,087	71,678	12,218
1994	374,885	58,649	9,997	108,088	16,925	2,885	482,973	75,573	12,882

### 2.3.3.2 Monetary Estimates

The estimated total cost of reducing pollutant discharges in the hog industry increased over the period 1988-1994. Total EPC was estimated at P 988 million in 1988 and increased to P 2,019 million in 1994, increasing at the rate of 12.9 percent every year (Table 2.3.3).

The actual EPE of the industry in controlling its pollutant discharges was estimated at P117 million in 1988 and at P281 million in 1994. This accounted for about 11.8 percent of the total EPC for 1988 and 13.9 percent for 1994.

The required EPE for controlling the uncontrolled pollutant discharges was about seven times that of EPE. REPE was estimated at P 871 million in 1988 and P1,738 million in 1994. This represents 88.1 percent of the total environmental protection cost and about 5.7 percent of the NVA (see Table 2.3.4).

TABLE 2.3.3 ENVIRONMENTAL PROTECTION COST, IN MILLION PESOS, 1988-1994

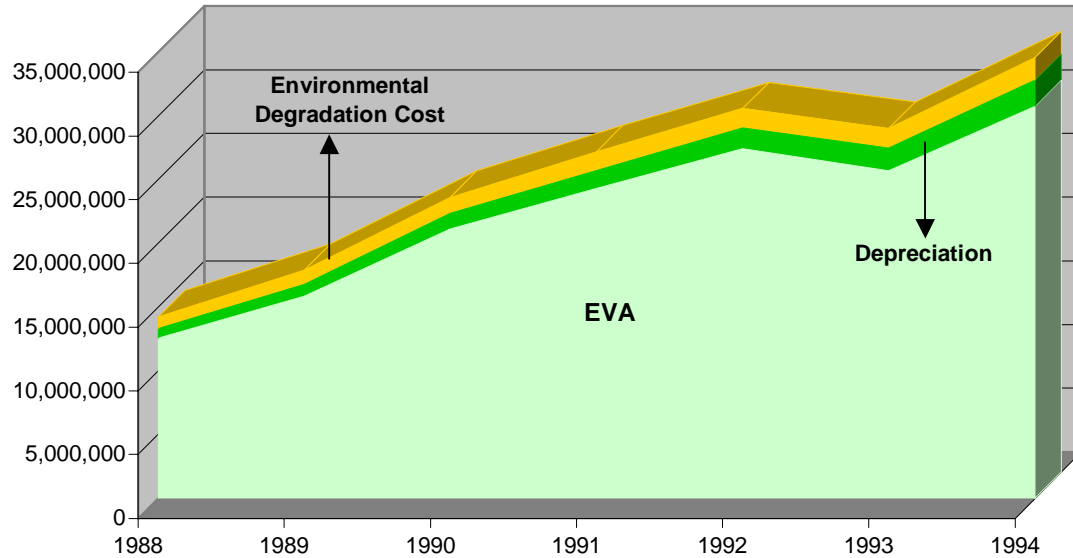
YEAR	Implicit Price Index - Private Construction (In Percent)	AnCC and AOMC (Per MT) for BOD Reduction	Environmental Protection Cost		
			Actual	Required	Total
1988	124.4	2.4	116.7	871.3	988.0
1989	148.0	2.9	140.7	1,078.1	1,218.8
1990	167.5	3.2	172.1	1,226.6	1,398.8
1991	198.8	3.9	227.5	1,440.7	1,668.2
1992	208.1	4.0	206.7	1,524.8	1,731.6
1993	214.7	4.2	226.5	1,552.2	1,778.7
1994	231.0	4.5	280.9	1,737.9	2,018.8

### 2.3.3.3 Environmentally Adjusted Net Value Added (EVA)

The EVA was estimated at P12,560 and P 30,775 million in 1988 and 1994, respectively, while NVA was recorded at P13,432 and P 32,513 million in 1988 and 1994, or an annual average growth rate of 16 percent. The computed EVA was 6.0 percent less than the NVA (Figure 2.3.2).

TABLE 2.3.4 ENVIRONMENTALLY ADJUSTED NET VALUE ADDED (EVA), IN MILLION PESOS (AT CURRENT PRICES), 1988-1994

YEAR	GVA [1]	Depreciation [2]	NVA [3]=[1]-[2]	REPE [4]	EVA [5]=[3]-[4]
1988	14,226.0	794.2	13,431.8	871.3	12,560.5
1989	17,887.0	948.8	16,938.3	1,078.1	15,860.5
1990	23,065.0	1,247.4	22,357.6	1,226.6	21,131.0
1991	27,180.0	1,407.3	25,772.7	1,440.7	24,332.0
1992	30,584.0	1,614.9	28,969.1	1,524.8	27,644.2
1993	29,024.0	1,759.3	27,264.7	1,552.2	25,712.5
1994	34,563.0	2,048.8	32,513.2	1,737.9	30,775.4



**FIGURE 2.3.2 HOG INDUSTRY: EVA, DEPRECIATION AND ENVIRONMENTAL DEGRADATION COST (AT CURRENT PRICES), 1988-1994**

### 2.3.4 RECOMMENDATIONS

In this study, the computed environmental protection was underestimated which could be addressed by accounting for other pollutants generated and their effects on the environment. In the physical estimates, only four pollutants namely: BOD<sub>5</sub>, SS, N and P were covered. In the monetary estimation, only BOD<sub>5</sub> reduction was accounted for. The unavailability of other data needed for the estimation has limited the coverage of the estimates.

More intensive efforts of concerned agencies are needed to monitor the environmental effects of the hog industry not only for commercial farms but also for backyard farms. One of the strategies, which can be adopted to monitor the pollution in the industry, is to enforce stricter requirements to the hog producers such as regular report to include the stocks of hog by farm type as well as the laboratory analysis of end-of-pipe wastewater discharges for submission to concerned agencies.

In assessing the extent of environmental degradation attributed to the industry, a survey of hog farms should cover the environmental data requirements namely: a) hog population by farm type; b) wastewater treatment plant used by type; and, c) actual environmental protection expenditures to include the detailed cost of capital, maintenance and operations.

Based on the results of this study, the following areas need to be taken into consideration to further refine the preliminary physical and monetary estimates:

- a) other pollutant emissions/discharges should be included in the estimation;
- b) estimation of EPC's should include the detailed expenditure cost of capital, maintenance and operations; and,
- c) the estimation of EPC's should include not only the BOD<sub>5</sub> discharges but also the cost of reducing other pollutant discharges to the standard level particularly SS, N, P and other pollutants.

APPENDIX TABLE 2.3.1

**WATER TREATMENT PROCESS (WTP), CAPITAL, OPERATIONS AND MAINTENANCE COST, IN THOUSAND PESOS, 1992**

Number of Hog Farms	Cubic meter per day	Number of hogs (Heads)	Unit Capital	AnCC	AOMC	Annual Total Cost	Cost/MT BOD Reduction
84	30	84,000	4,980	498	75	48,107	10.45
107	40	142,667	5,330	533	80	65,586	8.39
65	50	108,333	5,670	567	85	42,383	7.14
56	70	130,667	6,360	636	95	40,958	5.72
67	110	245,667	7,680	768	115	59,174	4.39
35	190	221,667	10,250	1,025	154	41,256	3.39
14	260	121,333	12,350	1,235	185	19,884	2.99
22	450	330,000	17,360	1,736	260	43,921	2.43
6	750	150,000	23,310	2,331	350	16,084	1.96
1	1,350	45,000	27,940	2,794	419	3,213	1.30
2	2,700	180,000	39,690	3,969	595	9,129	0.92
<b>Total</b>	<b>6,000</b>	<b>1,759,333</b>	<b>160,920</b>	<b>16,092</b>	<b>2,414</b>	<b>389,695</b>	<b>4.04</b>

Source: Industrial Efficiency Control Program, 1992.

Assumptions:

1. A 30 cm<sup>3</sup> per day Water Treatment Process (a joint 10 and 20) is required to treat wastewater generated by 1,000 hogs to meet the 95 percent BOD reduction standard.
2. Capital recovery is 10 years; estimation of capital costs assumed cost of land is zero.
3. Operations and maintenance cost is 15 percent (10-20 percent) of the annual capital cost.
4. 1,000 hogs generate about 54.8 mt BOD/yr; this corresponds to 0.15 kg/hd/day or 54.8 kg/hd/yr (based on MWSS).
5. 1992 unit capital cost is interpolated based on the 1992 IEPC Final Report.

APPENDIX TABLE 2.3.2

**POLLUTION LOAD FACTORS, IN KG/HEAD/YEAR, 1993**

PLF	Backyard Hog Farms <sup>1</sup>				Commercial Farms			
	BOD <sub>5</sub>	SS	N	P	BOD <sub>5</sub>	SS	N	P
	43.8	45.0	7.04	1.2	54.8	56.2	8.8	1.5

<sup>1</sup> PLF of backyard farms was assumed to be 20 percent lower than commercial farms

Source: Industrial and Environmental Management Program (IEMP)

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*Logging of Dipterocarp and  
Pine Forests*

## 2.4.1 INTRODUCTION

### 2.4.1.1 Industry Description

The forestry sector plays an important role in the Philippine economy and environment. It is the major source of timber, lumber, fuel wood and other wood based products for export and domestic consumption. It is also a rich source of food, clothing material, medicine and other raw material for various uses. Forests have also varied ecological uses. It provides the main watersheds of rivers, serves as effective protector of soils and regulator of water flows and carbon cycles as well as provide habitat for a multitude of animal and plant life.

Out of the total land area of 30,000,000 hectares of the country, fifty three percent or 15.88 million hectares were declared as forestlands, and 47 percent or 14.1 million hectares are classified as alienable and disposable. The remaining forests are only about 5.69 million hectares or 19 percent of the total land area of the country, and only 0.81 million hectares or 14 percent remained as dipterocarp old growth forests. The selective logging ban in 1992 placed the remaining dipterocarp old growth forests under conservation and protection of the National Integrated Protected Areas System (NIPAS). The residual forest on the other hand, comprised 2.96 million hectares or 52 percent of the total forest area. Given the government's strict imposition of the selective log ban, the gross value added for forestry continued to decline. From 11.26 billion in 1988, it went down to 2.98 billion in 1994.

### 2.4.1.2 Scope and Limitations of the Study

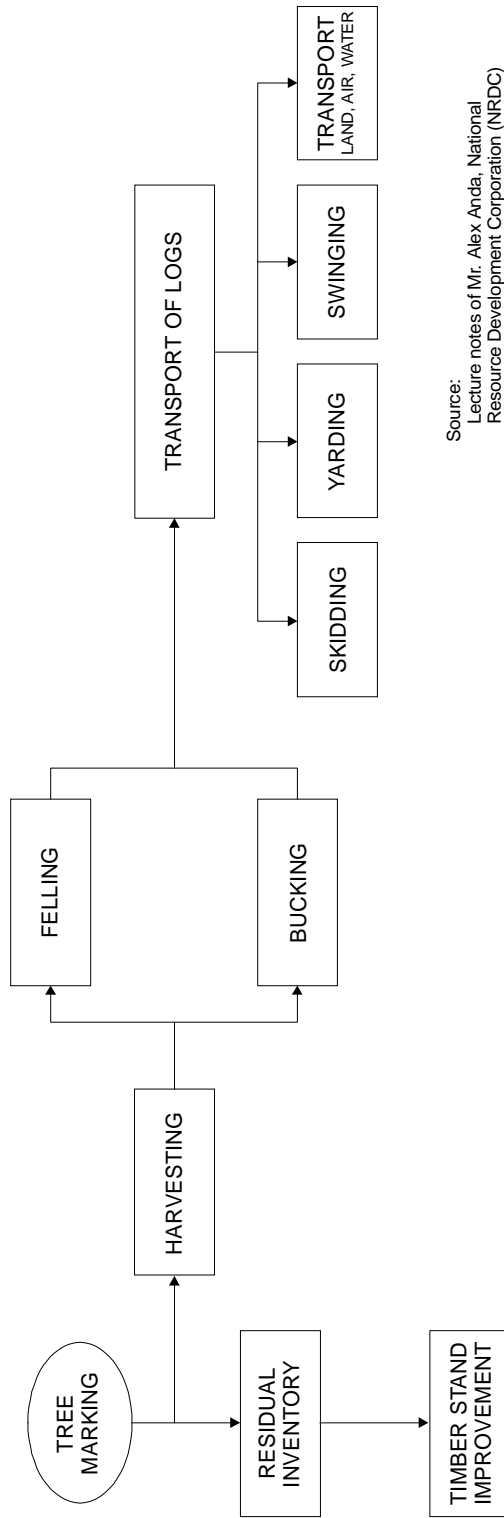
This study focused on the effect of logging activities to land, in particular. Land degradation occurs due to soil loss in logged areas. For the forest types used in the study, only dipterocarp and pine forests were covered due to data limitations.

### 2.4.1.3 Production Process

Selective logging is currently practiced In the Philippines. This involves the systematic removal of mature, over-mature and defective trees and to leave an adequate number of healthy residual trees of the commercial species and other tree species. This is necessary to ensure future crop of timber and forest cover for the protection and conservation of soil and water (Anda, 1996).

There are three phases of selective logging (Figure 2.4.1). The first phase is tree marking, that is marking trees to be cut and trees to be left including marking the direction of their fall. The second phase is the residual inventory that involves the evaluation of damages to the marked residual trees and the condition, size and number of healthy trees left. In the last phase, the timber stand improvement is done after logging to improve the number, growth and quality of the growing stock.

The harvesting of logs is done by felling and bucking. Felling is the cutting of trees using axe, crosscut saw or power-chain saw while bucking is the removal of limb and cutting felled trees into desired product length at stumpsite. Transport of logs are done from the stumpsite to the landing by skidding, yarding, swinging and transporting by road, water or air.



Source:  
Lecture notes of Mr. Alex Anda, National  
Resource Development Corporation (NRDC)

FIGURE 2.4.1 LOGGING INDUSTRY PROCESS FLOW

#### 2.4.1.4 Effects to Environmental Media

Logging activities affect both the physical and biological conditions of the environment. One of the damaging effects of logging activities is the depletion of forest resources that often results into soil erosion, causing siltation of water bodies, nutrient loss and organic matter depletion. Moreover, these activities contribute to the degradation of water quality of surface and ground water.

Biologically, the effect of forest destruction is the loss of biodiversity and destruction of habitat of flora and fauna species that often leads to their extinction. The loss of forest resources due to logging activities also affects the atmosphere. This threatens the ability of the biosphere to regulate atmospheric and biospheric cycles.

All stages of the logging activity results to soil erosion. Natural erosion also happens when there are no logging in the area, which are covered by the uncut erosion rate.

#### 2.4.1.5 Measures to Prevent Degradation to Environmental Media

Reforestation remains one of the major programs of the government to conserve and abate destruction of the forests. This activity involves the planting of trees on mountain base or in open lands that used to be covered with forest trees. The program also initiated the propagation of seedlings and saplings to restore the depleted forest. Both the government and the private sectors took part in the reforestation efforts. Nonetheless, reforestation efforts hardly kept pace with deforestation. In 1994, a total of 49,551 hectares of forestland was reforested. Thirty-six percent of the total area reforested was done by the DENR and 44 percent are from private sector efforts (PFS, 1994).

### 2.4.2 SOURCES AND METHODS

#### 2.4.2.1 Data Sources

Data used for the study were derived from administrative reports and special studies of research institutions. The Forest Management Bureau (FMB) provided data on the volume of log production by region. The Forest Asset Accounts compiled by the Technical Working Group (TWG) on Forest Resources of the ENRA Subprogramme, provided the parameters for the total logged areas of dipterocarp and pine forests. A study on Upland Soil Resources of the Philippines conducted by Dr. Francisco (1993) provided the data on woodland erosion due to logging at the regional level. The Asian Development Bank's (ADB, 1994) study on forestry was the source of indicator for erosion rates for cut and uncut forest. Wage rate indices were obtained from the Bureau of Labor and Employment Statistics (BLES). The data used for the estimation of environmental degradation costs were taken from FMB. The NSCB provided data on GVA and NVA.

#### 2.4.2.2 Estimation Methodology

##### 2.4.2.2.1 Physical Estimation

- **Total Logged Area (TLA)**

In physical terms, logged area which represents the total logged area of dipterocarp and pine forests was used (see Appendix Table 2.4.1). The available data on the volume of log production was used to arrive at the regional data for logged area (see Appendix Table 2.4.2).

- **Soil Erosion (SEL)**

Estimated soil erosion is equivalent to the amount of soil loss measured in metric tons. Soil erosion due to logging (SEL) is the product of the erosion rates due to logging (SEL<sub>Rt</sub>) and the total logged area. To estimate the soil erosion due to logging, the following assumptions were taken into consideration:

1. Erosion Rates Due to Logging (SEL<sub>Rt</sub>) = erosion rate of cut forest (SER<sub>cut</sub>) - erosion rates of uncut forest (SER<sub>unc</sub>)
2. Erosion rates for woodland by region, were used as indicators to come up with SER<sub>cut</sub> and SER<sub>unc</sub>. Regional differentiation of erosion rate (regional erosion rate/national erosion rate) of woodland was applied to the national erosion rate of cut and uncut forest to derive a regional dimension. SEL<sub>Rt</sub> for each region was derived as the SER<sub>cut</sub> less SER<sub>unc</sub> of that particular region (Appendix Table 2.4.3).

The above assumptions were operationalized as illustrated in the following equations:

$$\begin{aligned} \text{SEL} &= \text{SEL}_{Rt} \times \text{TLA} \\ \text{SEL}_{Rt} &= \text{SER}_{cut} - \text{SER}_{unc} \end{aligned}$$

All erosion rates were expressed in Metric Tons per hectare.

#### 2.4.2.2.2 Monetary Estimation

The maintenance cost approach was used to estimate environmental degradation due to logging. It represents the cost on a per hectare basis of the establishment, protection and maintenance of a forest area which covers cost for nursery operation and maintenance, including cost of putting up infrastructures. The cost per hectare was further disaggregated into labor cost and other costs i.e., supplies and materials, etc. (Appendix Table 2.4.4). These costs which were obtained from the FMB, assume the cost of reforestation per hectare. Data were available only for 1988. The wage index of laborers under non-agricultural establishments and the IPIN of the forestry sector based on GVA were used as proxy indicators to derive the cost for years 1989-1992. Labor wage index was applied on cost of labor while IPIN was used for other costs.

To arrive at the estimated environmental degradation cost, the computed costs per hectare was applied to the estimated total logged area which only cover logged areas under dipterocarp and pine forests (Appendix Table 2.4.4). This is summarized in the equation below:

$$\text{EC} = \text{TLA} \times \text{RFC}$$

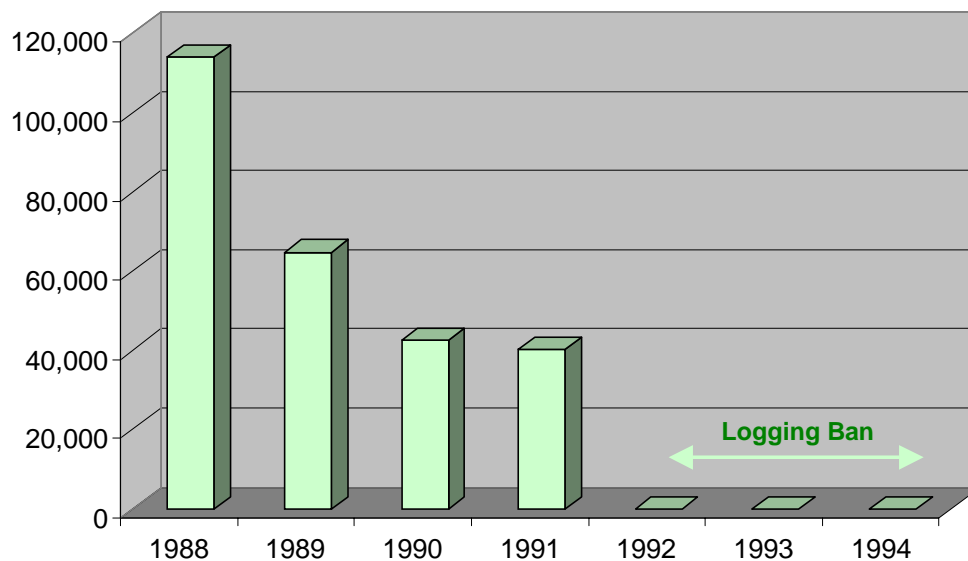
where:

$$\begin{aligned} \text{EC} &= \text{environmental cost} \\ \text{RFC} &= \text{reforestation cost per hectare} \end{aligned}$$

## 2.4.3 RESULTS

### 2.4.3.1 Physical Estimates

The total logged area in the country in 1988 was estimated at 114,145 hectares. In 1989, it went down by 43 percent of the 1988 level. In the succeeding years, total logged areas continued to decline until the total log ban. In 1992, total logged area was pegged at zero level with strict enforcement of the log ban. From 1988 to 1991, the total logged area declined at an annual rate of 5 percent. In 1991, it recorded a total of 40,250 hectares logged area. Figure 2.4.2 shows the trend of the logged area for dipterocarp and pine forests from 1988 to 1994.



**FIGURE 2.4.2 LOGGED AREA, DIPTEROCARP AND PINE FORESTS, IN THOUSAND HECTARES, 1988-1994**

Logging areas are concentrated largely in Regions 2, 10 and 11. This could be attributed to the mountainous terrain of these regions. Consequently, these regions contributed the highest volume of log produced (see Appendix Table 2.4.2).

Table 2.4.1 shows that the estimated volume of soil loss from the total logged area which was estimated at 362,493 MT in 1988, the highest recorded level during the four-year period. Parallel to the decrease in total logged area, the amount of soil loss exhibited a continuous decline from 1989 to 1991. In 1991, the amount of soil loss was at 137,948 MT, which is approximately one-third that in 1988.

**TABLE 2.4.1 TOTAL LOGGED AREA, LOG PRODUCTION AND SOIL EROSION DUE TO LOGGING, 1988-1994**

Year	Total Logged Area ('000 hectares)	Log Production ('000 cu. M.)	Total Soil loss due to logging (In MT)	Erosion Rates (MT/hectare)
1988	114,145	3,809,196	362,519	2.00
1989	64,755	3,168,949	212,163	3.27
1990	42,500	2,502,625	144,919	3.41
1991	40,250	1,921,595	137,948	3.43
1992	<b>LOG BAN</b>			
1993				
1994				

### 2.4.3.2 Monetary Estimates

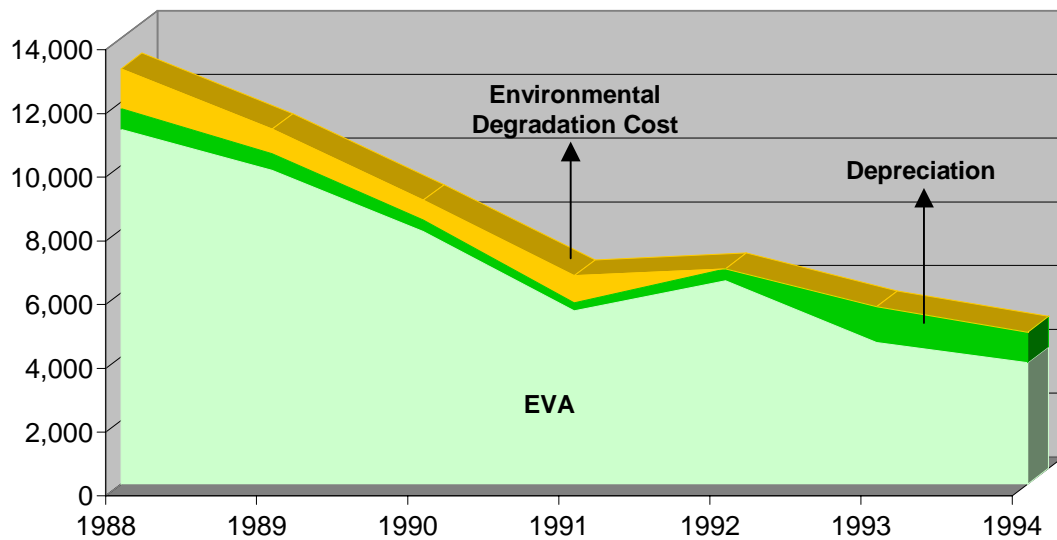
In 1988, the cost of environmental degradation due to logging activity was estimated at P1.25 billion, went down to P851 million in 1991 (see Table 2.4.2). As expected, the cost of environmental degradation decreased because of the reduction in total area logged. The decrease in cost, however, was cushioned by the increase in the average cost of reforestation activities.

### 2.4.3.3 Environmentally Adjusted Net Value Added (EVA)

In terms of value added, the estimated cost of environmental degradation due to logging industry in 1988 accounted for 11 percent of the EVA for the sector. Likewise, it comprised 10 percent of the NVA. From 1988 to 1990, cost of degradation continued to decrease at an annual rate of 12 percent. The trends of the EVA, depreciation and cost of environmental degradation are graphically presented in Figure 2.4.3.

**TABLE 2.4.2 ENVIRONMENTALLY ADJUSTED NET VALUE ADDED (EVA), IN MILLION PESOS (AT CURRENT PRICES), 1988-1994**

YEAR	GVA [1]	Depreciation [2]	NVA [3]=[1]-[2]	Environmental Degradation Cost [4]	EVA [5]=[3]-[4]
1988	13,036	654	12,382	1,247	11,135
1989	11,141	521	10,620	772	9,848
1990	8,907	358	8,549	621	7,928
1991	8,541	258	6,283	851	5,432
1992	6,763	374	6,389	0	6,389
1993	5,570	1,118	4,452	0	4,452
1994	4,770	957	3,813	0	3,813



**FIGURE 2.4.3 LOGGING INDUSTRY: EVA, DEPRECIATION AND ENVIRONMENTAL DEGRADATION, IN MILLION PESOS (AT CURRENT PRICES), 1988-1994**

#### 2.4.4 RECOMMENDATIONS

The attempt to estimate the extent of environmental degradation caused by logging activities has gone through several discussions and consultations with technical experts in the field. However, further validation of estimates (both in physical and monetary terms) and the data used (including parameters and assumptions adopted) has to be done to further refine the preliminary results of the study. Specifically, the following areas have to be addressed:

1. Data used to derive the environmental cost of degradation due to logging activity must be regularly generated by concerned data producing agencies. This will provide a better measure of environmental cost on a year to year basis.
2. The extent of degradation on other environmental media i.e., land, air, and water should likewise be estimated to determine the total effect of the activity to the environment.

APPENDIX TABLE 2.4.1

## TOTAL LOGGED AREA BY REGION, IN THOUSAND HECTARES, 1988-1991

Region	1988	1989	1990	1991
<b>Philippines</b>	<b>114,145</b>	<b>64,755</b>	<b>42,500</b>	<b>40,250</b>
CAR	0	1,204	16	68
1	841	107	0	1
2	21,178	11,811	8,449	5,759
3	111	82	89	0
4	8,331	5,966	5,690	3,314
5	270	176	0	26
6	0	0	0	94
7	0	0	0	0
8	8,256	1,955	548	581
9	7,798	3,052	1,839	2,195
10	22,054	12,062	5,430	7,633
11	37,744	21,893	15,661	19,710
12	7,562	6,447	4,777	871

Source: Philippine Forestry Statistics, FMB

APPENDIX TABLE 2.4.2

## LOG PRODUCTION BY REGION, IN THOUSAND CUBIC METERS, 1988-1991

Region	1988	1989	1990	1991
<b>Philippines</b>	<b>3,809,196</b>	<b>3,168,949</b>	<b>2,502,625</b>	<b>1,921,595</b>
CAR	0	58,943	960	3,227
I	28,076	5,237	7	45
II	706,736	577,983	497,537	274,931
III	3,692	3,994	5,238	0
IV	278,016	291,961	335,041	158,200
V	9,014	8,590	0	1,258
VI	0	0	11	4,475
VII	0	0	0	0
VIII	275,527	95,689	32,275	27,730
IX	260,231	149,350	108,309	104,780
X	735,975	590,305	319,741	364,400
XI	1,259,567	1,071,376	922,212	940,961
XII	252,362	315,521	281,294	41,588

Source: Philippine Forestry Statistics, FMB

APPENDIX TABLE 2.4.3

## EROSION RATES IN THE PHILIPPINES BY REGION, IN METRIC TONS PER HECTARE

Region	Woodland (1)	Cut Forest (2)=[(1)/2.08] x 2.6	Uncut Forest (3)=[(1)/2.08] x 0.6	Due to Logging (4)=(2)-(3)
<b>Philippines</b>	<b>2.08</b>	<b>2.60</b>	<b>0.60</b>	<b>2.00</b>
CAR	2.54	3.18	0.73	2.44
I	0.53	0.66	0.15	0.51
II	3.85	4.81	1.11	3.70
III	1.24	1.55	0.36	1.19
IV	5.50	6.88	1.59	5.29
V	0.69	0.86	0.20	0.66
VI	0.74	0.93	0.21	0.71
VII	0.27	0.34	0.08	0.26
VIII	1.70	2.13	0.49	1.63
IX	1.03	1.29	0.30	0.99
X	3.50	4.38	1.01	3.37
XI	3.62	4.53	1.04	3.48
XII	1.72	2.15	0.50	1.65

Source: Upland Soil Resources of the Philippines, Resource Assessment & Accounting for Soil Depreciation, Forestry Sector Study of the Philippines, ADB

APPENDIX TABLE 2.4.4

## ESTIMATED MAINTENANCE COST OF LOGGED FOREST, IN PESO PER HECTARE, 1988-1992

Year	Index of Wage Rates <sup>1</sup>	Index of Wage Rates <sup>2</sup>	Inflation Rates of IPIN <sup>3</sup> Forestry Sector	Cost per Ha. <sup>4</sup>		
				Labor	Others	Total
1988	100.00	1,986	-	7,626	3,301	10,927
1989	111.38	2,212	3.68	8,494	3,422	11,916
1990	131.12	2,604	1.25	11,137	3,465	14,602
1991	154.43	3,067	13.60	17,199	3,937	21,135
1992	162.84	3,234	16.80	28,006	4,598	32,604

Sources:

<sup>1</sup> derived by dividing the Index of Wage Rates<sup>2</sup> present year value with the base year (1988) multiplied by 100

<sup>2</sup> 1995 Yearbook of Labor Statistics, BLES

<sup>3</sup> National Accounts, NSCB

<sup>4</sup> FMB

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