Agri-nipa-aquaculture: a sustainable mangrove-friendly technology

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Mangrove ecosystems throughout the Philippines are constantly threatened. In most cases, the basis of the threat is simple economic gain. Such exploitation of mangroves may either be direct as in the case of clearcutting and conversion to fishpond or indirect in the case of fuelwood gathering, charcoal production and timber extraction.

The economic advantage associated with mangrove exploitation has, in the past, been counted as a socially valuable contribution to the human community. In recent years however, a rising chorus of voices has questioned the nature of such advantage, asserting that this exploitation represents net cost of society.

Mangrove species (including nipa) have a use value that has not been accounted for by traditional economics (Harger, 1982). Mangroves have varied uses: source of food, firewood, poles, foundation piles and raw materials for the manufacture of glue, dye, tea, tannin, resin and adhesives for plywood manufacture, honey, sugar, medicine, roofing/thatching materials, charcoal, vinegar, dissolving pulp, rayon and livestock forage/ feed supplement.

At the ecosystem level, mangroves provide essential spawning grounds that permit the reproduction of some fishes and shellfishes and at the same time serve as nursery for some offshore shrimps and fishes. Mangrove ecosystems are highly productive entities that contribute a major share of the energy requirements in offshore ecosystems where a close dependence between mangroves and fisheries productivity exists.

The contribution of mangroves to nearshore fisheries is supported by studies that show a positive relationship between mangrove area (r=0.89), total length of mangrove-lined rivers (r=0.96) and shrimp catches (Martosubroto and Naamin 1977; Staples et al. 1985). A positive correlation between Philippine municipal fisheries catches and existing mangroves (r=0.72) has been documented by Camacho and Bagarinao (1987).

Fig. 1. The pilot agri-nipa-aquaculture site in Puerto Galera was first planted with nipa seedlings. Deep perimeter dikes were later constructed and stocked with tilapia.

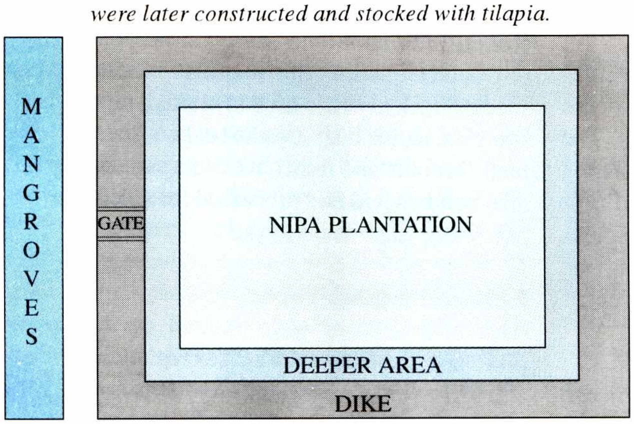

Fig. 2. Layout of the agri-nipa-aquaculture scheme

In the past decade, concurrent with the rise in population was the increased demand for aquaculture, agriculture, and industrial development. Consequently, areas originally dominated by mangrove forests have been cleared for fishpond development. In 1967, mangrove forests totalled 418,990 hectares. After 15 years, this area was reduced to 239,387 ha (BFD, 1984). At present, the remaining mangrove areas in the Philippines are only 120,500 hectares (EMB, 1995). The reduction represents 73% of the mangrove area at the start of the century. The SPOT survey in 1988 revealed that 95% of the present fishpond areas between 1952 to 1987 are derived from mangroves.

Unwise exploitation may eventually lead to loss of genetic biodiversity in the mangrove ecosystem (Serrano and Fortes 1987). A point may be reached wherein future generations may be deprived of this unique environment.

To redress this deteriorating scenario, strategies for alternative land uses for coastal areas must be developed and implemented, all within the concept of sustainability. These strategies must provide for regeneration of mangrove forests and at the same time satisfy the needs for human survival.

One of the technologies tested and known to positively affect coastal areas is aquasilviculture which harmonizes planting of mangrove trees with fish production. The technology however limits income generation to only fish production

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during the first 7 years of operation, since harvest or thinning of planted mangrove trees can only be implemented in the 8th year. An alternative which can be considered as a variation of aquasilviculture is the implementation of Agri-Nipa-Aquaculture (ANA) as a sustainable land use combination. The strategy combines planting of nipa and agricultural crops with fish production. This article describes the ANA pilot project of the Department of Environment and Natural Resources in Puerto Galera, Philippines.

The project site

The ANA pilot project is in Sigayan, Tabinay, Puerto Galera, Oriental Mindoro. Productivity of the area prior to ANA establishment was very low since the site was mostly covered with tall reed grass. An area measuring 1,400 m^2, located in the central part was already planted to nipa while rice (5,000 m^2) was planted in the southern part. Rice production was very poor according to the farmer because of its proximity to the sea and salt sprays carried by winds.

The project started in March 1989 and ended December 1996.

Protection of existing mangrove stands

At the start of the project, the second growth mangrove stand fringing the site was protected from wood gatherers. The mangrove area is about 3.68 ha consisting of six species. The mangrove stand protect the site from strong waves, typhoons and strong winds. Some open areas and skips were planted to *Rhizophora* species.

Fishponds

It took three months to plan and construct the nipa-aquaculture ponds.

Two fishponds were constructed (Fig. 1-3). One was around the newly established nipa plantation (Pond I), and the other was around the established mature nipa stands (>2 years) (Pond II).

Tilapia and milkfish fry were stocked in each pond. Mixed stocking was also done.

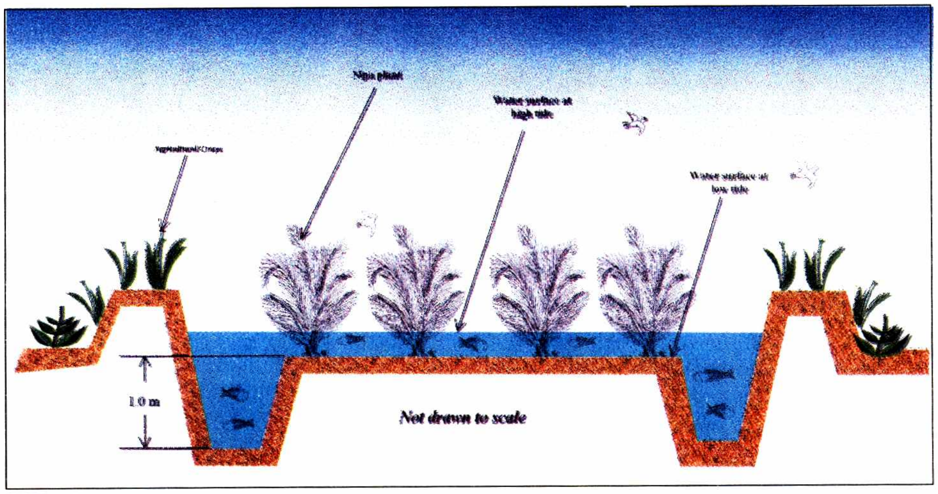

Fig. 3. Cross section of agri-nipa-aquaculture pond indicating water level during low and high tides

Nipa plantation

Nipa accounted for 80% of the central portion of ponds I and II. Nipa seedlings about 4-5 months old were used to plant Pond I. The seedlings were spaced either 1 or 2 m apart.

Nipa was used instead of mangrove trees because of its higher economic potential in the area which can be compared with coconut in terms of economic value. Its ecological role includes erosion control, coastal protection and stabilization, and provision of sanctuaries for some marine species. Its leaves are used in making nipa shingles, native bags, coarse baskets, hats, mats, brooms and raincoats. Nipa sap can also be extracted and processed into alcohol, wine, sugar and vinegar.

Fruit and vegetable crops

Agricultural crops were planted on the dikes and available open spaces within the site to maximize use of the area. This is to provide immediate and added source of food and income since it takes 3-4 years before nipa can be utilized for income generation. Crops found to adapt to saline conditions of the pilot site were banana, tomato (*marikit* variety), pole *sitao*, bush *sitao*, eggplant, *upo*, *okra*, pineapple, passion-fruit, peanuts, corn, *patola*, and jackfruit.

Mangrove litter and other coastal debris that were washed ashore were collected and used as organic fertilizer and soil conditioner. Laboratory analysis showed that mangrove litter has adequate nutrient contents to support good crop production, as shown below:

pH	6.20
Organic matter	15.27%
Nitrogen	0.76%
Phosphorus	10.35%
Potassium	0.81%
Calcium	43.91%
Magnesium	24.21%
Sodium	7.74%
CEC*	55.51 meq/100 mg soil

* cation exchange capacity or the capacity of the soil to hold cations and to exchange species of these ions in reversible chemical reaction

From the data generated, the best variety of bush *sitao* under the prevailing condition is UPLB-3 with a yield of 2.77 kg per m^2 per crop. There were seven other varieties tested.

For pole *sitao*, all three varieties tested were high yielding. On top is *sandigan* variety with a yield of 11.29 kg per m^2 per crop.

Tomato (*marikit* variety) yields 9.75 kg per m^2 or 97.5 tons per ha which is very high compared to its upland counterpart which rarely exceeds 30 tons per ha. Corn (32 pieces per m^2) and other crops have also very good yields.

TABLE 1 Fish production in the agri-nipa-aquaculture system (tons per ha per crop)

Cropping cycle	Pond I (newly established nipa) Tilapia	Shrimps[1]	Others[2]	Pond II (w/ mature nipa stand) Milkfish	Shrimps[1]	Others[2]
1st crop	1.62[a]	0.05	0.17	d	d	d
2nd crop	1.58[b]	0.10	0.06	1.71[e]	0.08	0.03
3rd crop	1.55[c]	0.07	0.06	1.40[f]	0.06	0.05
4th crop	1.57[b]	0.02	0.03	1.68	0.07	0.01
5th crop	1.60[b]	0.03	0.10	1.66	0.06	0.04
6th crop	1.65[a]	0.01	0.03	1.70	0.03	0.03
7th crop	1.54[b]	0.01	0.05	1.58	0.02	0.01
Average	1.59*	0.04	0.07	1.62**	0.05	0.03

[1]majority are freshwater shrimps; [2]mullet, mudfish, tarpon, sea bass, etc.
[a]sex reversed tilapia; [b]mixed sex tilapia; [c]golden hybrid tilapia; [d]construction stage;
[e]milkfish only; [f]mixed milkfish and tilapia
*approx. 3.18 tons per ha per year; **approx. 3.24 tons per ha per year

Fish production

Two species of fish were cultured in the ponds -- milkfish and tilapia (mixed sex, sex-reversed and golden hybrid). Stocking rates were 2-3 fingerlings per m^2. Supplemental feeding with commercial feeds and rice bran was given amounting to 5% of the fish biomass weight per day. Pond preparation was done prior to each crop. Two crops were stocked yearly. Activities for pond preparation included pond drying, fertilization for growing food algae and water management.

Harvest data showed an annual average of 3.18 and 3.24 tons per ha per year of tilapia and milkfish, respectively (excluding other species) at two crops per year (Table 1). Other fishes were also harvested.

Milkfish and golden hybrid tilapia were the most preferred in the local market. With pole fishing becoming a popular recreation in the area, tilapia can be considered as a highly potential species for ecotourism.

Nipa production

The first harvest of fronds from the newly established nipa at 3 years old (Pond I) is shown below:

Spacing of nipa	*Production (no. of fronds)	*Length (cm)
1 m apart	125.67	155.01
2 m apart	234.00	180.05

*Average of three replicates. Area for each replicate is 120 m^2. Each replicate has either 99 plants (for nipa spaced 1 m apart) or 20 plants (nipa spaced 2 m apart)

For nipa planted 1 m apart, it took 2.75 fronds to produce one shingle; while two fronds from nipa planted 2 m apart were needed.

Harvest from Pond II was about 4 fronds per nipa palm (now >5 years old). About 1.5 fronds made up a shingle. Harvesting was done every 4 months.

At the project's end, the cooperator-farmer had a net income of ₱81.00 from nipa planted 1 m apart in a 120 m^2 plot or about ₱20,250 per ha per year. From nipa planted 2 m apart, the annual net income is ₱52,500 per ha per year.

The shingle produced in the project was especially made to order by resort owners in Puerto Galera. The leaf sewed together was double, with a total length of 1.7 m. Two ordinary commercial shingles were equivalent to a shingle made from the site; and the farmer-cooperator claimed that it will last for at least 10 years.

Soil quality

There was soil degradation at the site. The new nipa plantation had loam type of soil, becoming sandy loam three years later. The mature existing nipa area was sandy loam, later becoming silt loam. Below is the comparative soil analysis in the nipa plantation:

	Pond I Mar '89	Pond I Feb '92	Pond II Mar '89	Pond II Feb '92
pH	6.80	3.50	7.10	4.4
Organic matter	3.68	8.09	3.68	1.48
Nitrogen	0.18	0.41	0.18	0.07
Phosphorus	7.34	3.07	4.78	5.75
Potassium	0.96	0.23	0.21	0.18
Calcium	7.61	8.57	6.84	6.25
Magnesium	7.11	6.47	2.11	4.09
Sodium	36.96	1.70	1.82	1.22
CEC	**6.47**	**11.81**	**46.26**	**12.22**
% sand	51.00	54.00	53.00	32.00
% silt	39.00	39.00	31.00	51.00
% clay	10.00	7.00	16.00	17.00
Textural grade	Loam	Sandy loam	Sandy loam	Silt loam

Project impact and recommendations

The ANA pilot project shows that a coastal area can be made productive through the agri-nipa-aquaculture scheme. While waiting for the nipa to be harvested for making thatching materials or for sap production, the farmer can harvest vegetables and other crops, and fish from the pond for his food or to augment family income.

Tables 2-3 show the projected income of a backyard nipa-aquaculture farm in the first few years of operation.

One of the limitations of ANA is the need for some source of freshwater. This means that not all coastal areas use this system. Freshwater is needed for the fishponds and also to produce brackishwater conditions ideal for the growth of nipa and tilapia.

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TABLE 2 Projected income from fish and nipa of a 1,000 m^2 backyard nipa aquaculture farm for the first three years of operation (pesos)

Activities	*Unit cost*	*Year I*	*Year II*	*Year III*
Aquaculture				
Digging 20% of the area (20 man-days)	₱ 120.00	2,400.00	-	-
Tilapia fingerlings, sex-reversed	0.30	450.00	450.00	450.00
Feeds, manure, fertilizers		2,000.00	2,000.00	2,000.00
Repair and maintenance		-	400.00	400.00
Nipa plantation				
Clearing for nipa planting (1 man-day)		80.00	-	-
Hole digging (2 man-days)		160.00	-	-
Planting (1 man-day)		80.00		
4-5 month old nipa seedlings	5.00	1,250.00	-	-
Maintenance (4 man-days per year)		320.00	320.00	320.00
Nipa harvest				
Tie	0.10	-	-	280.00
Bamboo sticks, 1.5 m	0.10	-	-	260.00
Labor, per 50 shingles	50.00	-	-	2,808.00
Shingle assembling and sewing		-	-	2,808.00
Gross income / sales				
2 harvests with 80% survival, (5 pcs fish per kilo)	30.00	14,000.00	14,000.00	14,000.00
Nipa shingles, 1.5 m long / double		-	-	11,232.00
Net income (before tax)		**7,660.00**	**11,230.00**	**16,284.40**

TABLE 3 Projected income from banana and vegetables of a 1,000 m^2 backyard agri-nipa-aquaculture farm for the first five years of operation (pesos)

	No. of plants	*Price per bundle*	*Year I*	*Year II*	*Year III*	*Year IV*	*Year V*
Banana							
Saba	100	60	-	6,000	6,900	7,935	9,125
Lakatan	20	85	-	1,700	1,955	2,248	2,585
Poot	50	42	-	2,100	2,415	2,777	3,194
Total			-	**9,800**	**11,270**	**12,960**	**14,904**

Basic assumptions: (1) yearly increase of 15% on price of bananas and (2) yearly production of banana is 1 bundle per plant

	Harvest	*Price*	*Year I*	*Year II*	*Year III*	*Year IV*	*Year V*
Vegetables							
Pole *sitao*	188 kg	12/kg	2,256	2,594	2,983	3,430	3,945
Bush *sitao*	100 kg	12/kg	1,200	1,380	1,587	1,825	2,099
Tomato (*marikit*)	100 kg	5/kg	500	575	661	760	874
Corn	375 pc	2/pc	750	862	991	1,140	1,311
Upo (cooking variety)	200 pc	3/pc	600	690	794	913	1,050
Total			**5,306**	**6,101**	**7,016**	**8,068**	**9,279**

Another problem is fish predators which may enter the pond with the tide. Predator control is a must.

Initial capital is also needed especially in the establishment phase which coincides with the first year of operation.

There is also a tendency for the soil to become acidic. Liming is recommended once every three years.

Other recommendations are as follows:

- Natural stocking from the wild should be studied and the profitable species for culture determined
- Stocking of some mollusc species should be studied together with the fish species
- Value-added products from nipa should be explored
- More crop varieties should be screened for saline/coastal soils

REFERENCES

Baconguis SR, DM Cabahug Jr and SN Alonzo-Pasicolan. 1990. Identification and inventory of Philippine forested wetland resource. Forest Ecol. Manage. 33/34:21-44

Bina RT. 1978. Mangrove inventory of the Philippines using LANDSAT Multisectoral Data and IMAGE 100 system. NRMC Research Monograph 2:1-8.

Brown WH and and AF Fischer. 1902. Philippine mangrove swamps. In: WH Brown (ed). Minor products of Philippine forests. Bureau of Printing, Manila. p 17-125

Camacho AS and T Bagarinao. 1987. Impact of fishpond development on the mangrove ecosystem in the Philippines. *In:* Mangroves of Asia and the Pacific: Status and Management. Tech. Rep. UNDP/UNESCO Research and Training Programme in Mangrove Ecosystem in Asia and the Pacific (RAS/79/002). p 383-406

Dent D. 1986. Acid sulfate soils: a baseline for research and development. International Institute for Land Reclamation and Improvement/ILRI. The Netherlands. 204 pp

Harger JRE. 1982. Major problems in the functional analysis of mangroves in Southeast Asia. *In*: Mangrove Forest Ecosystem Productivity in Southeast Asia. Biotrop Spl. Publ. No. 17, p 55-59

Martosubroto P and N Naamin 1977. Relationship between tidal forests (mangroves) and commercial shrimp production in Indonesia. Mar. Res. Indonesia 18:81-86

Melana DM. 1982. Research and development

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New waste disposal system for poultry-fish culture

By T Muthu Ayyappan

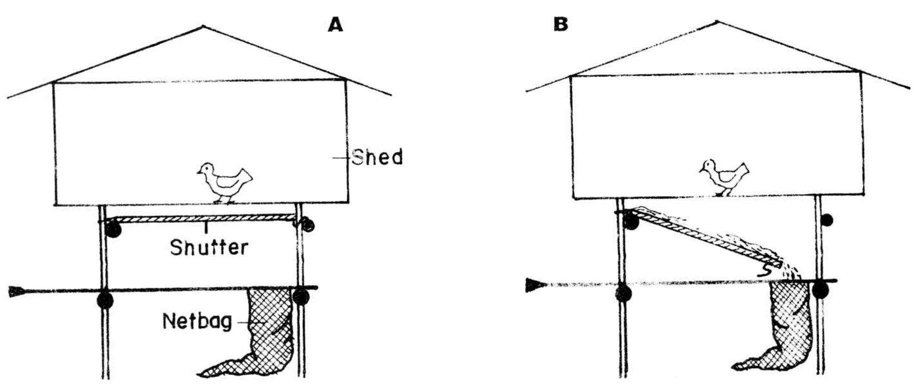
In poultry-cum-fish culture, the droppings of birds form a valuable source of manure for pond culture. It also serves as a direct food for the growing fish.

But bird wastes can not be left where these are dropped by birds in the pond because these just accumulate, becoming of little use to farmers. Collection of wastes from bird sheds and adding them to the pond is inconvenient and time-consuming. This article describes a new system that overcomes these disadvantages.

Collecting bird droppings

To collect bird droppings, the shutter is released from the shed bottom. The slope of the open shutter makes the droppings fall into the net bag (figure B). The net bag is moved through the pond near the surface of the water. The long handle pole makes this work easy and convenient.

This process may be done periodically as required.



Construction

The floor of the bird shed is made up of loosely packed frames of bamboo or other suitable local material. Below the shed floor is a shutter made up of closely packed frames. The shutter is fixed under the floor with a hinge on one side. A hook system is provided on the other side to lock or release the shutter when required. A net bag of small mesh size with rectangular mouth frame and a long handle is kept under the shed on two carrier rods. See figure A.

Uses

- The application of this system prevents eutrophication as bird wastes are no longer accumulated at one site
- Waste collection is convenient and time-saving
- Frequent collection of wastes minimizes the risk of disease outbreaks in birds
- Bird droppings can be spread more evenly throughout the pond as fertilizer or fish food

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status of Philippine mangrove. *In*: Mangrove Forest Ecosystem Productivity in Southeast Asia. Biotrop Spl. Publ. No. 17, p 127-146

PCARDD. 1989. Problem soils in the Philippines. Soil and Water Tech. Bull. Vol. VI

Sakardjo D. 1982. *Tumpang sari* pond as a multiple use concept to save the mangrove forest in Java. *In*: Mangrove Forest Ecosystem Productivity in Southeast Asia. Biotrop Spl. Publ. No. 17

Staples, DJ Vance and DS Heales. Habitat requirement of juvenile penaeid prawns and their relationship to offshore fisheries. In: PC Rothlisberg, BJ Hill and DS Staples (eds). Second National Prawn Seminar, NSP2, Cleveland, Australia, p 47-54

Taguiam G. 1991. Personal communication

Urriza GIP, VV Babiera, P Evangelista and MR Recel. 1990. Characterization and management of problem soils. III. Management of acid sulphate soils for prawn production. Soil and Water Technical Bulletin VII (7): 1-18

Van Breeman N and LJ Pons.1987. Acid sulfate soils and rice. *In:* Soils and rice. International Rice Research Institute, Los Baños, Laguna, Philippines.

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Probiotics ... from p 13

tion of food-borne bacterial pathogens by bacteriocins from lactic acid bacteria isolated from meat. Appl. Microbiol. 57: 1683-1688

Montes AJ, Pugh DG. 1993. The use of probiotics in animal food practise. Vet. Med. 88: 282-288

Sunilkumar M. 1995. Probiotics: an emerging concept in aquaculture nutrition and disease control. Sea Food Export (July 1995): 5-9

Uma A, Abraham TJ, Jeyaseelan MJP, Sundararaj N. 1995. Influence of a commercial probiotic feed supplement on the growth, survival and immunity of Indian white shrimp *Penaeus indicus*. Tamilnadu Veterinary and Animal Sciences University, India ###