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SEAWEED HUSBANDRY: A SOCIO-ECONOMIC ISSUE

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Introduction

This paper attempts to present data obtained from completed and on-going researches on Philippine marine macro-algae and to trace its possible linkage with the issue on socio-economics.

Overview

Archipelagic countries like the Philippines confine most of their rich harvest from the sea to animal materials like fin-fish, shell-fish and sea mammals. The marine plant materials, predominantly seaweeds, compose only a small fraction of the resource gathered from the marine habitat. This, despite the fact that most of these marine macro-algae have varied uses ranging from food staples, industrial, biomedical, and agricultural needs, to a more revolutionary use, stemmed from the concept of 'biomass energy'. These remarkable uses of seaweeds if seriously tapped in the less developed or developing countries, specifically those within the periphery of the Pacific Basin, is expected to favor the balance of their economy and improve the social status of the populace. More than just being contented with harvested seaweeds feral in nature, there is no assurance in any manner of predictable commodity. There is, therefore, a need to introduce seaweed husbandry imbued with the idea of judiciously utilizing specific seaweed species herein termed as *crop*, conservation of resources, propagation of superior species, and an assurance of continuously renewable supply of the crop.

The elements of husbandry adopted for terrestrially-produced agricultural crops are also applicable to edible seaweeds or sea vegetable algae, thus:

1. Identification of the seaweed species with emphasis on the physiology and morphology of the economically useful part of the crop. In the case of seaweeds such as *Eucheuma*, *Gracilaria*, and *Porphyra*, the entire thallus is the economic organ.
2. Characterization of the eco-niche of each species as a guide to plot their distribution as well as determine the optional population density for maximized production output.

3. Introduction of structural and nutritional technologies designed to ensure dominance of the crop over wild stock herein considered weeds.
4. Ensuring effective growth control techniques upon the crop with the end in view of determining the approximate regularity of harvest season.

Husbandry, more associated with the domestication of crops, when applied to seaweeds may cover its sustained production as well as the regulated foraging of economically useful species. Briefly, husbandry may fall within the context of managed cultivation and harvest of marine plants/seaweeds. Successful husbandry necessitates healthy research and development (R and D) activities on the crop to be domesticated. R and D as precursory step to seaweed husbandry once applied in the Philippines may be determined by some factors:

1. The necessity to meet market demand.
2. The need to operate profitably within the sphere of legal and ethical constraints.

As in any business the acceptance of seaweed husbandry through the medium of mariculture practice of economically viable species is geared at maximizing production to meet market demand. Thus, the goal of most businessmen in order to keep alive their industry is to bloat the return of investments (ROI) of the stockholders, corporate partners or government funding agencies acting as investors and/or owners. This is done by getting involved in sound investments in profitable ventures. Definitely R and D programs, in any language, are among the most speculative of investments. Sad to say, that the atmosphere for R and D lending is at its ebb at present in the Philippines. This bleak picture is attributable to the following reasons:

1. Insufficiency and diverting of money available for innovative R and D projects to tasks way down the ladder of priorities.
2. Disenchantment among technically trained personnel/researchers to get involved on R and D activities, a repercussion of the aforementioned factors.
3. Absence of an integrated seaweed research center where R and D programs may be initiated.
4. The issue on poor money management by lending agencies has led to fears of gross economic collapse. The idea of risk-avoidance mentality simply discourages R and D expenditures.
5. Growing skepticism about the credibility of benefits that science and technology can offer. This is based largely on a poor understanding of what science is and how its results should be handled.
6. The energy crunch in the early 1970's has caused a shift of innovative efforts to energy conservation and disenchantment from product development efforts.

The net result of these factors, unless checked in due time, is a tremendous socio-economic displacement aggravated by reduced financial support for in-house basic research in seaweeds. One of the more timely remedies to this socio-economic upheaval (low production out-put and subsequent dislocation of workers), is emphasis on 'fire-fighting' projects to save our unindustrialized seaweed resources through the introduction of husbandry of seaweeds.

Seaweeds as Export Commodity

Many valuable species of marine macro-algae have never been tested, and many more including some previously mentioned in literature, have still unrealized potential. The results of a completed research, described a total of seventy six (76) species of useful seaweeds gathered from several points in the Philippines (Cordero, 1980).

Also, a progress report covering year one (October 1982-September 1983) of an on-going project based on Panay Island presents significant data on the identification, seasonal occurrence and distribution of forty-two (42) species of sea vegetable algae (Cordero, 1983). Both the 1980 and the 1983 projects, proofs of the richness of our seaweed resources and their potential export capabilities, drew fundings from the National Research Council of the Philippines (NRCP) and the National Museum (NM). Among the potentially economic seaweeds described are *Caulerpa, Eucheuma, Gracilaria, Gelidiella* and *Porphyra* – enjoying extensive distributions in both flanks of the country, but for *Porphyra* which is confined to northern Luzon.

Until the first half of the 1960's the Philippines seaweed export relied mainly on harvesting unmanaged natural/wild stock materials of *Eucheuma* and *Gracilaria*. The pressing needs for higher quality and greater stability and quantities of certain seaweed species, drove the innovative industrialists and farsighted governmental agencies to look toward managed cultivation, or mariculture, as ready answer.

The development of seaweed mariculture has progressed at an imperceptibly snail's pace compared to terrestrial-based agriculture. As expected, crops underwent boom-and-bust cycles dictated with radical price fluctuation in the international markets. Incidentally, in the late 1960's mariculture made its debut in the Philippines using *Eucheuma* as stock material (Doty, 1973). The technology introduced was nonetheless exciting considering that it involves the use of vegetative propagation through cuttings or fragmentation of thalli.

Endowed with favorable ecological parameters, including its geographical location in the tropical region, the Philippines boasts of a rich natural seaweed population. Not only do these crops serve to supplement the harvestable and exportable items, their locations serve also as natural guide for mariculturists where to fix their culture set-ups.

Incorporation of mariculture harvest (*Eucheuma*) with those natural stocks gathered as feral crops (*Gracilaria, Sargassum*), helped improve the Philippine

seaweed export as gleaned from the ten-year Bureau of Fisheries and Aquatic Resources (BFAR) report, thus:

Year	*QUANTITY (Kgs.)*	*VALUE (₱)*
1971	473,511	163,979
1972	259,049	237,164
1973	522,649	307,121
1974	2,099,195	4,825,378
1975	3,675,939	10,749,605
1976	5,900,000	13,152,965
1977	8,136,500	15,152,389
1978	85,824,000	18,612,030
1979	106,107,000	58,568,219
1980	115,652,000	63,730,358

Likewise, noteworthy was our 1979 and 1980 seaweed exports to several countries, top five being the following:

COUNTRIES	*QUANTITY (Kgs.)*	*VALUE (₱)*
Denmark	4,878,066 and 4,524,372	13,229,769 and 11,230,920
USA	4,243,116 and 2,285,848	19,551,505 and 21,013,106
Germany	1,535,500 and 914,000	4,070,353 and 93,240
Japan	1,890,811 and 1,678,606	10,073,107 and 12,014,883
Spain	1,196,000 and 1,479,500	3,382,400 and 3,576,745

One should note that the figures presented above are purely results of the introduction of mariculture technology using *Eucheuma* species. Considerably, this red carrageenophytic alga constitutes the bulk of our seaweed export commodity. However, using the 1978 data provided by the BFAR Regional Office in Cebu, the brown *Sargassum* shows the following export statistics, mostly to Japan (c.f. Cordero, 1981):

September 1978 . . . . . 97,000 kilos (dry weight)
October 1978 . . . . . 214,400 kilos (dry weight)

Another seaweed exported to Japan from Cebu, is *Caulerpa* although figures are not available.

Indeed, mariculture, while this brought about financial benefits to some Filipinos, is one significant facet in seaweed husbandry. If we are to think about the

Japanese experience on their successful *Porphyra* mariculture and its subsequent husbandry, we should be thinking about doubled production for each breakthrough in cultivation methodology adopted by them.

Porphyra, one of the first seaweeds to be industrialized, is largely produced and managed in every suitable bays in Japan. The slow but progressive improvement in the Japanese cultivation technique resulted in an industrial production of about 860 million sheets of the papery, protein-rich red algae per year between 1938 – 1947 and increasing to 6 billion in 1970. Five years later, 7.1 billion sheets (278,127 tons net weight) were produced giving a return of investment of $380 million (Kurogi, 1975).

Incidentally, in the Philippines, where three known species of *Porphyra* grow (*P. crispata, P. marcosii* and *P. suborbiculata*), mariculture of this seaweed promises to be a rewarding venture (Cordero, 1974).

A feasibility study conducted on the sea farming of the genus *Porphyra* (*P. marcosii* Cordero and *P. suborbiculata* Kjellman) in the Philippines (J. M. Cordero, 1982), reveals encouraging results, thus:

I. *Financial Aspects.* The proposed corporation shall have a ₱400,000 shares at ₱100 per share. Of the ₱400,00 authorized, 62.5% or ₱250,000 worth shall be subscribed and paid up by five incorporators/stockholders.

The ₱249,300 required investment will be financed through equity of five incorporators who will each contribute ₱50,000 in order to start the project.

One culture net, measuring 14 meters long and 1.5 meters wide with 12 cm. wide mesh, is expected to yield 20 kilos (net weight) of fresh *Porphyra* for three harvests (800 nets x 20 kilos) = 16,000 kilos = 5,333 dried *Porphyra.* The selling price is ₱180.00 per kilo or ₱30.00 per dried sheet (8-10 inches in diameter), to increase at 10% annually based on an average inflation rate.

B. *Prospected Income:*

The expected sales and net income for five years are shown as follows:

TIME (Year)	*GROSS SALES (Kgs.)*	*NET INCOME (₱)*
Year 01	767,880	160,910
02	929,016	222,832
03	1,125,228	308,543
04	1,362,816	435,561
05	1,649,049	618,435

II. *Demand Forecast.* The demand forecast could be gleaned from viewing the total target and categorizing them into two segments of the market.

1. *Primary Market.* Restaurants and hotels in Metro Manila including those

found in major cities, serving Japanese foods and catering to the middle and upper income groups and the tourists flocking the Philippines, especially the Japanese averaging about 193,465 annually. Per information gathered from 54 big hotels and food establishments, each establishment uses approximately 1,000 kgs of *Porphyra* for regular Filipino customers and about 25,795 kgs annually for tourists coming to the Philippines. Hence, the total demand forecast is about 1,446,948 kgs.

Another primary market for the products are the Japanese residing in the Philippines which number around 3,500 consisting of about 1,500 households. Again, based on interviews, each household consumes about 1 kg of *Porphyra* per month or a total of 18,000 kgs monthly.

The other primary market are the people of the Ilocos Region. The 1,064,0841 potential consumers were determined by assuming that 30% of the total households in the Ilocos Region would consume a modest amount of 1 kg of *Porphyra* a year. The 30% of assumption was based on the economic level of the population who can afford this particular commodity. Hence, considering then that there are 3,543,642 population in the Ilocos Region (Philippine Year Book, 1981), the total demand forecast is about 1,063,089 kgs.

2. *Secondary Market.* The secondary market shall be the Filipinos who have learned to eat and accept the nutritive values of *Porphyra.* Of the total Metro Manila population of 5,843,000 (Philippine Year Book, 1981), the potential market is assumed to be 2% only. The percentage consumption is a conservative one considering that the commodity to be offered is new to most of the populace so much so that it is assumed that each of the 116,872 individuals will consume at least 0.5 kg of *Porphyra* annually.

The total demand forecast for both the primary and secondary markets is 2,586,473 kgs per annum.

It is projected that the corporation will be able to penetrate its target market of 100% after year three of its first five years of operation.

Based on computations, net income is expected to increase by 38% annually.

III. *Socio-Economic Implications.* The proposed project anticipates to bring about several economic benefits to various sectors.

a. *To the Incorporators.* An expected annual income of ₱272,964 or an average of ₱54,592 per incorporator appears highly realistic. This will generate an earning of 109% for each incorporator's investment of ₱50,000. These earnings pooled together could be reinvested to expand

the business as to include other commercially important seaweed species.

b. *To the Government.* The Philippine government stands to profit from the proposed project in the form of income taxes paid by the corporation, the individual incorporators as well as by the major employees of the firm.

c. *To the Society.* The project expects to save several establishments, viz., hotels, restaurants, dollars in the importation of dried *Porphyra.* This will help provide the low income Filipinos, specifically, cheap source of protein, iodine, etc., once *Porphyra* becomes acceptable as part of their meals. Additionally, the project expects to help solve partially unemployment by hiring laborers to attend to the maintenance of the seaweed farm, harvesting, drying, packing and handling of the product for marketing and distribution purposes.

Our *Eucheuma* production from feral crops to mariculture through vegetative propagation minus husbandry, shows the following figures; thus, our harvest dwindled from a high of 1,000 tons in 1968 to 318 tons in 1973; export from 805 tons to 264 tons dry weight (Caces-Borja, 1973). In 1974, the production figure improved following limited investment in R and D done by one foreign-financed business outfit. Thus, from the premariculture production figure of 500 tons (dry weight) harvest in 1973, it skyrocketed to over 10,000 tons. One thing is, however, discernible between the *Porphyra* and *Eucheuma* projects of Japan and the Philippines, respectively. The former is owned totally by the Japanese, while the latter is not owned by the Filipinos.

Prospects of Seaweed Husbandry

When referring to whether seaweed husbandry is present or practical to introduce in the Philippines, consideration should be given the following questions:

1. Is there seaweed husbandry in the Philippines?

As pointed earlier, while mariculture of *Eucheuma* had its foothold in the Philippines during the latter half of the 1960's, no trace of husbandry went with it, technically speaking! Superficially, however, the cultivation of the two genera *Caulerpa* and *Eucheuma* may be considered to have reached the minimal level acceptable under the cropping system standard. Species of green *Caulerpa* (*C. racemosa* and *C. lentillefera*), are cultivated vegetatively through cuttings and are broadcasted in fish ponds of Mactan Island, Cebu. While that of *Eucheuma (E. striatum, E. spinosum,* and *E. cottonii*), the large scale cultivation initially located in Mindanao are now mostly found in select waters in the Visayas and in the South China Sea Coast of the country. Again, while *Caulerpa* cultivation is owned by Filipinos, *Eucheuma* culture activities are run by foreign capitalists. It is evident that the principal concern

of the *Eucheuma* capitalists appear more of producing the crops to feed their respective mother/foreign based companies where processing of the raw material into industrial, biomedical and food products take place.

The answer, therefore, to the above question is YES, but only to a limited extent, **Also,** that elements of husbandry are applicable to both feral crops composed of *Caulerpa, Sargassum, Eucheuma, Gracilaria, Gelideila* and *Porphyra* species as well as the cultivated species of *Caulerpa* and *Eucheuma.*

2. What is the state-of-the-arts of seaweed or sea vegetable algae husbandry obtaining in the Philippines?

The issue raised by this question is whether the current state-of-the-arts of sea vegetable algae husbandry accepts the possibility of its being packaged for future technology transfer.

While it is accepted that experiments have been done to propagate and culture sea-vegetable algae as the green *Caulerpa* and the red *Eucheuma, Gracilaria,* and *Porphyra,* only select species of the first two are presently being cultivated. The cultivation levels of *Caulerpa* and *Eucheuma,* barely quantifiable as crop husbandry, are more appropriately classified as a fishpond and an open ocean practice, respectively.

Acceptably, however, while both *Caulerpa* and *Eucheuma* have reached the commercial stage of production as an evidence of acceptance of husbandry elements, still the agronomic measures needed to package a transferable technology have not been credibly delineated, quantified, and confirmed in field practise to allow large scale promotion of these marine resources. The anemic information on agronomic parameters necessary in the successful husbandry of seaweeds may find remedy through R and D efforts as well as relevant basic researches.

Assessment and Projections

Further refinement of the current mariculture technology is expected to improve the state-of-the-arts of sea vegetable husbandry considered key to the birth of a successful seaweed industry of the country. Somehow, we should try to graduate from too much dependence on the monoculture of *Eucheuma* and *Caulerpa* vegetative propagation often dubbed as a quick-payback investment. Now on its second decade, proponents of seaweeds mariculture have yet to come up with innovative culture methods including studies on the plant's biology or using reproductive characters as guide toward production of better strain or cultivar.

It appears from the foregoing discussion that *Caulerpa* and *Eucheuma* have safely attained the stature of cultivated crops, and that the elements of responsible husbandry are positive for these two sea vegetable species.

It might be worthy of note that in order to attain true commercial successes, following an appropriate management scheme of the seaweed industry, will depend on how fast we could change from monoculture to polyculture practice. In the latter practice several species of seaweeds and/or other crops interact synergistically. By adopting the polyculture system, overhead and operational costs would be spread over two or more commercial operations and would likewise allow extensive recycling of nutrients and water within the culture area.

It is ripe, therefore, that a viable crop production package of technology for both *Caulerpa* and *Eucheuma* be collated taking into account the experiences and observations of mariculture experts in places where these twin marine crops are presently successfully cultured.

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Gregorio T. Velasquez, Discussant

It has been observed that an audience with biological interest like this afternoon is present to listen to the symposium. No other than the President of the University of the Philippines here at Diliman also arranged a series of symposia recently with speakers like our scientific program in the National Academy of Science and Technology. They were drawn from among the faculty of the University, leaders of economics and selected politicians. Several members of the faculty and students attended to participate and discuss with the speakers. The symposia meant to evaluate the exchange of opinions primarily to offer solutions to the present state of the government and economy in the country. We wish then that our exchange of opinions today led by our speaker is equally fruitful.

Dr. Cordero mentioned among others that two species of *Eucheuma, Porphyra* and *Gracilaria* have been known as sources of carrageenan and possibly local sources of agar used by the people especially in the rural districts. Success has been shown in *Eucheuma* as presently a large source of the local dollar-earning towards the nation's economy. *Porphyra* and *Gracilaria* are beginning to attract also similar sources of dollar-earning needed at present.

But if we can suggest other red algal specimens such as *Hypnea musciformis, Laurencia pinnatifida* and *Gracilaria verrucosa,* I believe that these marine benthic algae can be useful as good sources of exportable food like the three genera already mentioned above. The latter genera grow also in abundance in the local seas.

The Philippines is an archipelagic country composed of seven thousand islands where seventy-five percent are marine waters, the rest freshwaters. On top of these records the freshwater in agriculture has most likely reached the maximum development production of our staple food. The fertilizers imported from abroad can not be available these days in agriculture. The prices are prohibitive since we do not have sufficient dollars. Even the saltwater of the sea has diluted our freshwater used in some ricefields. Hence, the nation should keep alert of this slow but destructive change in the local ecology.

But how can our alertness suit to the present national disaster? Below then may be indeed very timely suggestions:

1. That while Dr. Cordero has informed us of the exportable food resources like
2. *Eucheuma*, with the varieties: *E. striatum* (cottonii of commerce), *E. spinosum* and possibly *Porphyra crispata* now included in the present mariculture. *H. musciformis, L. pinnatifida* and *G. verrucosa* can be added.
3. Only with exception that the algae for the selected stocks in propagation be planted to adapt themselves to the ecosystem where they grow best.
4. With time permitting the inclusion of genetic experiments and selection in the processing of better stocks should be done simultaneously.

5. And lastly, it is important that our workers in the field be possessed with interest and dedication to do the follow-up of the experiments in order to realize the excellence of results. The maturation of the mariculture as in *Eucheuma* is needed to realize the objectives.