An insight into the weeds of dark waters for animal health and wealth

Uma visão sobre as ervas daninhas das águas escuras para a saúde e a prosperidade dos animais

Una visión de las malas hierbas de las aguas oscuras para la salud y la riqueza de los animales

DOI:10.34117/bjdv10n5-033

Submitted: April 08th, 2024
Approved: April 26th, 2024

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ABSTRACT
Today’s world be it man or animal, there is scarcity of good food and nutrition with many health issues. The animal world especially is not fodder secure with over 500 million animals to feed in our country alone. The process of deforestation and concretisation of the land, reduced farming land, low farming affinity, crop losses and low harvests due to demineralisation of the land can be attributed as the cause for this. At this juncture the search for alternate fodder sources have led our way to the “SEA VEGGIES” MISNOMERED as Sea weeds. These form nearly 70% of the earth’s plant treasure wherein only 1% of it has been utilised as of now. Seaweeds have nearly 63 minerals, protein to a max. Of 60%, apart from all vitamins (except vit-D), Omega 3 fatty acids, flavinoids and carotenoids. Apart from being good sources of food, they have industrial usage in the form of Algin, Alginic acid and Carragenan. Used as fertilizers and soil binders, in waste water treatment, in cosmetics and medicines. Our ancient wisdom has given an insight into the usage of seaweeds to feed and treat the animals. Our work embarks upon the prospect of the use of seaweeds in the health and nutrition of animals and found to be the best alternative yet to be tapped.

Keywords: sea veggies, protein, agar, nori, thallasotherapy, kainic acid, microcidal, more milk and eggs.
RESUMO
No mundo de hoje, seja no homem ou no animal, há escassez de bons alimentos e nutrição, com muitos problemas de saúde. O mundo animal, em especial, não está seguro quanto à forragem, com mais de 500 milhões de animais para alimentar somente em nosso país. O processo de desmatamento e concretização da terra, a redução das terras agrícolas, a baixa afinidade agrícola, as perdas de safras e as baixas colheitas devido à desmineralização da terra podem ser atribuídos como a causa disso. Nesse momento, a busca por fontes alternativas de forragem nos levou aos "SEA VEGGIES" MISTÉRIOUS como ervas daninhas do mar. Elas formam quase 70% do tesouro vegetal da Terra, sendo que apenas 1% dele foi utilizado até o momento. As algas marinhas têm quase 63 minerais, proteínas no máximo. De 60%, além de todas as vitaminas (exceto vit-D), ácidos graxos ômega 3, flavonoides e caretonoides. Além de serem boas fontes de alimento, elas têm uso industrial na forma de algína, ácido algínico e carragenina. São usados como fertilizantes e aglutinantes de solo, no tratamento de águas residuais, em cosméticos e medicamentos. Nossa sabedoria ancestral nos deu uma visão sobre o uso de algas marinhas para alimentar e tratar os animais. Nosso trabalho aborda a perspectiva do uso de algas marinhas na saúde e na nutrição dos animais e descobriu ser a melhor alternativa ainda a ser explorada.

Palavras-chave: vegetais marinhos, proteína, ágar, nori, talasoterapia, ácido caínico, microcida, mais leite e ovos.

RESUMEN
En el mundo actual, ya sea para el hombre o para los animales, hay escasez de buenos alimentos y nutrición, con muchos problemas de salud. El mundo animal, en particular, no dispone de forrajes seguros, ya que sólo en nuestro país hay más de 500 millones de animales para alimentar. El proceso de deforestación y concretización de la tierra, la reducción de las tierras de cultivo, la escasa afinidad agrícola, las pérdidas de cosechas y las bajas cosechas debidas a la desmineralización de la tierra pueden atribuirse como causas de esta situación. En esta coyuntura, la búsqueda de fuentes alternativas de forraje nos ha conducido a las "VEGEJAS MARINAS" mal llamadas "algas marinas". Éstas constituyen casi el 70% del tesoro vegetal de la Tierra, del que hasta ahora sólo se ha utilizado el 1%. Las algas marinas contienen cerca de 63 minerales y un máximo de proteínas. Además de todas las vitaminas (excepto la vitamina D), ácidos grasos Omega 3, flavonoides y caretonoides. Además de ser buenas fuentes de alimento, tienen un uso industrial en forma de algína, ácido algínico y carragenano. Se utilizan como fertilizantes y aglutinantes del suelo, en el tratamiento de aguas residuales, en cosméticos y medicamentos. Nuestra sabiduría ancestral ha permitido comprender el uso de las algas marinas para alimentar y tratar a los animales. Nuestro trabajo se embarca en la perspectiva del uso de las algas marinas en la salud y la nutrición de los animales y se revela como la mejor alternativa aún por explotar.

Palabras clave: algas marinas, proteínas, agar, nori, talasoterapia, ácido caínico, microcidas, más leche y huevos.
1 INTRODUCTION

Seaweeds or Sea vegetables are forms of algae that grow in the sea and are highly nutritious, they draw an extraordinary wealth of minerals from the sea up to 36%. So a little goes a long way.

To understand this idea better, today we are not fodder secure, feeding nearly 500 million and more animals in our country alone. With the agriculture production stagnating and farmers shifting to grow other crops that do not yield fodder. The cultivable land is coming down due to urbanisation and water shortage thus limiting livestock production and keeping becomes difficult sometimes impossible too.

Seaweeds contain Tyrosine and Iodine that is 59 times more than the RDI requirement. They are good sources of vitamins like A, C, E, K and B12 mainly. Minerals like Iron, Manganese, Copper, Zinc, Sodium, Calcium, Magnesium and Omega 3 fatty acids are in abundance. Also contain protective antioxidants making free radicals less reactive like Flavonoids and Carotenoids especially Fucoxanthin which protects the cell membranes 13 times more than Vitamin – A. Excellent source of fibre making up to 25% of its dry weight. Particular sugars found in seaweed called Sulfated polysaccharide have been shown to increase the growth of good gut bacteria, they increase production of SCFA (Short Chain Fatty Acids) slow the process of stomach emptying, help in reducing weight, reduce cholesterol and blood sugar levels thereby keeping the heart healthy. The carbohydrate Fucan prevents blood clotting inside the blood vessels, alginate blood sugar spiking. Seaweeds like Laminaria, Undaria, Porphyra act as good sources of food for human and animal.

Nearly 70% of world’s oxygen comes from seaweeds and algae. There are 9 times more seaweeds in the oceans than there are plants on the land. But we have used only 1/100th of its 1 percent total biomass.

Nearly 2 tonnes of seaweed is consumed as Wakame, Kombu, Nori, Deluse around the world.

Since time immemorial seaweeds have found their stake in health care too.

Irish moss used in hospital dressings to treat wounds, burns, rashes, to control TB, flu, obesity and cysts.

Seaweed baths clear skin eczemas.

This study attempts to understand the benefit of seaweeds in maintaining the health and wealth of the animal world.
Sea has the untapped resource of seaweed available in large quantities. Sea weeds were used as animal feed as early as 1st century BC itself. They are rich in protein (25 – 60%), Carbohydrate (30-70%), Vitamins, Minerals and all essential amino acids and other organic substances. When given to Cow the milk yield increased, when used in poultry the egg size, shell and the number increased. This aspect increased the curiosity on seaweeds and their utilization in animal husbandry.

2 SEA VEGGIES AND THEIR SIGNIFICANCE

Seaweeds are generally made up of 3 distinct recognisable parts, a root like structure called Hold fast or Frond, a stem like connecting part the Stipe and leaf like Lamina not true leaves. The single cel can be very small or can be nearly 1 cm in size. These are not true plants but behave like plants, these convert sunlight into chemical energy and release oxygen as a byproduct. During the day time consume 80% of the carbon dioxide available.

The mineral content is 10 times more than terrestrial plants endowed with trace minerals and vitamins. Also contain large volume of soluble and insoluble dietary fiber with low calorific value. Contain all important amino acids, that are not synthesised in animal body. Contain Mannitol, Sorbital and Laminarin that have high industrial value.

Primary mineral components are Iodine, Sodium, Calcium, Phosphorus, Magnesium, Iron, Potassium, Chloride, Zinc, Copper, Manganese, Selenium, Molybdinium, Chromium, Vitamin – A, B (B1, B2, B3, B6, B12 and Folate) C and E. DMSP (Di Methyl Sulfanio Propionate) is an important antioxidant, it has no taste or smell.

3 SEA WEED CATEGORISATION

These marine plants misnomered as seaweeds are categorised mainly based on their pigmentation and widely come under 3 categories – Green algae- Chlorophyceae, Red algae – Rhodophyceae and Brown algae – Phaeophyceae.

GREEN ALGAE – Come under Chlorophyceae, their pigmentation is due to the Chlorophyll -a and Chlorophyll - b, present in the same proportion as in higher plants.

Caulerpa, Ulva lactuca and Enteromorpha are few examples.
RED ALGAE – Rhodophyceae. The red colour of these results from the pigments Phycocyanin and Phycoerythrin.

*Porphyra, Gracillaria, Gellidium, Chondrus, Carollina and Palmaria* are some examples.

BROWN ALGAE – Phaeophyceae – The brown colour of these algae results from the presence of Xanthophyll pigment Fucoxanthin

*Laminaria, Ascophyllum, Sargassum and Saccharina* are some examples.

4 COMMERCIAL ECONOMIC ASPECTS OF SEAWEEDS

4.1 WEEDS TO WEALTH

Source of Algin
Source of Agar
Source of Carragenan
As Fertilizer & Soil Conditioner
As Bio Fuel
In Waste water treatment

4.2 WEEDS FOR HEALTH

As Human food
As Cosmetic
As Medicine

4.3 INDUSTRIAL USAGE

Algin present in the cell walls of Brown Sea Weeds that is partly responsible for flexibility of seaweeds is used in many ways. Algin got from sea weeds like *Ascophyllum, Sargassum & Laminaria* acts as a thickening agent for aqueous solutions and in farming.

Agar extracted from agarophytes like *Gelidium, Gelidiella, Gracillaria, Pterocladiella* is used as a gelling agent for elaboration.
Carragenan extracted from *Chondrus, Eucheuma, Kappaphycus* is also an important gelling agent.

### 4.4 AS FERTILIZER AND SOIL BINDER

There is a long history of coastal people using sea weeds especially the brown seaweeds to fertilize nearby land. The seaweed that is washed to the shores is collected, dried, cut into pieces and strewn on the fields.

In some places, the sea weeds are mixed with sand, left to rot and then dig it into the soil, remineralising the fields.

Seaweeds are collected, dried, powdered and mixed with other vegetable waste, made into a compost and used in vegetable, fruit and flower gardens, they seem to be getting the greatest benefit.

In summer large quantities of green seaweeds are cast ashore, this is composted and used for tomato plants. The usage of this increased the water holding capacity of the soil, production cost decreased, no other fertilizer is used and is environment friendly.

Maerl is a fertilizer derived from red seaweeds that grow with the crust of calcium carbonate on the outside. The red calcareous red algae, *Phymatolithon calcareum* and *Lithothamnion coralloides* are used to neutralise acid soils, as a substitute for agriculture lime.

When used with NPK fertilizers, improves the effectiveness of the fertilizers, so less can be used with lowering of costs.

There are always those who prefer an organic or natural fertilizer, especially in horticulture, so seaweed extracts probably have a bright future (Crouch & Van Staden 1993).

### 4.5 AS BIOMASS FOR FUEL

In 1974 the American Gas Association decided to look for a renewable source of Natural gas (Methane). A project to produce seaweed on farms in the oceans, harvesting it and convert it to Methane, by the process of anaerobic fermentation. This project was divided into two parts one for the production and harvesting of seaweed (Biomass) and the other for the conversion of biomass to energy (methane that could be burnt to produce energy). The seaweed chosen was “*Giant Kelp*” and “*Macrocystis pyrifera*”. The bench
work indicates that net energy can result from bio conversion with good yields of 
methane.

4.6 IN WASTE WATER TREATMENT

There are two main areas where seaweeds have the potential for use in waste water 
treatment. The first is the treatment of sewage and some agricultural wastes, to reduce the 
total nitrogen and phosphorus containing compounds before the release of these waters 
into the rivers and oceans. The second one is for the removal of toxic metals from 
industrial waste water.

Eutrophication is the enrichment of water with nutrients such as minerals, nitrogen 
and phosphorus containing materials. This leads to the unwanted and excessive growth 
of aquatic and marine plants. An example for this is the excessive blooming of Ceratium 
in the sea that could hinder the nutrient cycles and also lead to shallowness and 
stagnations leading to fatalities at times. Seaweeds facilitate the nutrient cycle in these 
conditions. Seaweeds like Enteromorpha and Monostroma are of interest because of their 
commercial value. (Abraham, T.J. & Priyadarsani, L. 2019)

The accumulation of heavy metals (Copper, Nickel, Lead, Zinc) by seaweeds 
became apparent when they were tested for human consumption. This led to the idea of 
using seaweeds as biological indicators of heavy metal pollution. By using dried and 
milled seaweeds like Sargassum, Laminaria, Ecklomia, Ulva, Enteromorpha, Lessonia, 
Durvillaea, were able to absorb Copper, Nickel, Lead, Zinc, Cadmium ions from the 
water.

After the extraction of Agar, Algin or Carragenan the waste product is insoluble 
and mostly made of Cellulose which has excellent absorbing properties. Another waste 
product from the production of Kelpak the liquid fertilizer is good to absorb Copper, 
Cadmium & Zinc.

4.7 AS HUMAN FOOD

For several centuries China, Japan and Korean people have used seaweeds as food. 
Indonesia and Malaysia have followed the same footsteps.
Already in many countries cooking recepies using seaweeds/sea veggies are in circulation with the current trend for consumers to embrace organically grown foods and natural foods from clean environments seaweeds receive an increasing acceptance.

“NORI – PORPHYRA” – Most nutritious seaweeds with a protein content of 30 – 50% with about 75 % of that is digestible, low sugar, very high vitamin content. The characteristic taste is due to the large amount of 3 amino acids, Alanine, Glutamic acid and Glycine (Oohusa 1993).

Nori is used mainly as a luxury food, it is often wrapped around the rice ball of Sushi, a typical Japanese food, of a small handful of boiled rice with a slice of raw fish on top, is incorporated into soya sauce and boiled down. Also used for making of jam and wine seasoning of fried foods.

AONORI OR GREEN LAVER - (Monostroma & Enteromorpha). One celled thick with average 20% protein with vitamins and high levels of Iron and Calcium minerals. This is processed into sheets dried and boiled with sugar, soya sauce to make Nori jam.

KOMBU OR HAIDAI – (Laminaria) With 10% protein, 2 % fat, minerals & vitamins. This is collected folded dries and cut into 1 m long strips and marketed. Cooked with soups, served with Herring or Sliced Salmon.

WAKAME (Undaria) – Very high fibre content, low fat, very rich in Vit- B, especially Niacin along with Mn, Cu, Co, Fe, Ni, Zn, in soups, salads, used as luxury food.

DULSE (Palmaria palmate) – This is a red alga with leathery fronds broken into flakes or ground into powder for use as seasoning added to chips. It can be eaten raw, cooked with potatoes, in soups and with fish. Iron content is very high.

IRISH MOSS OR CARRAGENAN MOSS (Chondrus) – A source of carragenan, used for its thickeneing property when boiled in water, it makes a traditional pudding – BLANCMANGE.

OGO OR SEA MOSS (Gracillaria) – Collected and sold as a salad vegetable. Mixed with raw fish, made into jellies and as a base for a non-alcoholic drink.

CAROLA OR SEA FARINA (Callophyllis) – Fine for baking, used as salt substitute or condiment.

GREEN GRAPES OR GREEN CAVIAR (Caulerpa) – Used as additive in puddings, for seasoning salad. Luxury food.

AS COSMETIC
Found in cosmetic packages of face, hand, body as creams and lotions.
Milled seaweed is used as an additive in bath water to enhance skin texture and colour.

**THALASSOTHERAPY** – Mineral rich sea water is used in a range of therapies including hydrotherapy, massage and a variety of mud and algal treatments. This treatment covering the body with seaweed paste and warming with infrared lamp relieves from rheumatic pain and removal of cellulitis.
Seaweed cream is told to restore elasticity and suppleness to the skin.

4.8 AS MEDICINE

Used as curative for TB, arthritis, cold and influenza.
Worm infestations mainly Digenea has been effectively controlled due to Kainic acid in the seaweeds.

Antiviral properties.
Corallina is being used in bone replacement therapy (Stein & Borden 1984)
Saccharina stipes are used in Obstetrics to dilate the cervix (Stein & Borden 1984)
Remove phlegm and in the treatment of Goitre (Oriental Materia Medica)

This is just a small insight into the magnanimous benefits of the seaweeds. The present study is trying to focus on the aspects of Health and Wealth due to seaweeds usage, its prospects in the Animal world.

5 SEAWEED FOR ANIMAL HEALTH AND WEALTH

These days there is much work going on globally in relation to animal health and its direct impact on the human economy.

5.1 SEAWEED IN ANIMAL HEALTH

a) Efficient to fight antibiotic resistance and climatic change;
b) Immune booster;
c) High levels of Zinc in seaweeds kill *E.coli*;
d) The Phlorotannins can kill bacteria as they emerge;
e) Seaweeds absorb Carbon Dioxide and help to deacidify the soil and water, release oxygen, making the environment of the animal healthier;
f) *Ascophyllum (Kelp)* is known to treat skin ailments, allergies, seizures and obesity related to thyroid function. Iodine and Selenium in the seaweed helps in this correction;
g) Sodium in seawaters shrink lipomas in animals (Dr. Connie Dinatale);
h) Act as a lymphatic, kidney, spleen, renal cleaner. Also helps to control heart ailments. (Dr. Cynthia);
i) Sea weeds help to achieve good skin coat, hoof & hair growth (Rick Palmquist);
j) Have shown to have been used in balancing endocrinal imbalances;
k) Help to detoxify the body after exposure to mouldy feeds (mould inhibitor).

5.2 NUTRITIONAL VALUE OF SEAWEED IN ANIMALS

a) Seaweed resources can be used as fodder or food for animals either raw or processed;
b) Seaweeds like *Enteromorpha, Ulva, Sargassum, Hypnea, Gracillaria, Chaetomorpha, Coulrepapa* etc, can be used as fodder;
c) Seaweeds stimulate appetite, improve digestive capacity, increase production and performance levels;
d) Study on the nutritive value of seaweeds in the laboratory with rumen fluid from seaweed fed sheep showed that the digestability of seaweeds was very high;
e) Seaweeds when fed as additives at 1 – 2 % of the feed showed good response to health and meat quality;
f) *Laminaria* and *Fucoidin* improved the piglet performance and good gut health;
g) *Ascophyllum nodosum* fed broilers showed an increase in growth due to high level of amylase, this had a positive effect on feed intake FCR and improvement in breast meat;
h) *Sargassum* and *Enteromorpha* were beneficial to egg quality, egg production, shell thickness increased weight and yolk colour;
i) In feeding trials with poultry adding *Ascophyllum* to the diet increased Iodine content in eggs;
j) When fed with seaweed the cattle, Sheep and dairy cows showed an average increase of 6.8% in milk production, this means 13% more income;
k) The Ewes fed with seaweeds maintained their weight and gave greater wool;
l) P.vannemi of high saline waters like that of the Sundarbans get benefit from seaweeds like Ulva, Enteromorpha and Gracillaria, the presence of which reduced the Vibriosis load in those waters and also provided a place to hide during the post molting condition.\(^\text{15}\)
m) In abalone feeding and aquaculture, the wet feed consists of meat waste mixed with dry additives forming a doughy mass when thrown into water, disintegrates. Here when the technical grade of Algin is added acts as a binder keeping the feed together. Algin itself acts as a binder keeping the feed together. Algin itself is a good feed supplement;
n) Gracillaria is used to feed Salmon. In Taiwan Gracillaria is grown in fish ponds, wherein the fish waste is used up as fertilizer by Gracillaria, to grow and the fish water effluent was sent into a seaweed tank with Ulva. This seaweed grew luxuriously, this was in turn used to feed the cultured organisms. These grew well and the production cost came down by 30%.

6 STATUS AND PROSPECTUS

a) Japan is the leading seafood importer and consumer, nearly 71,800 tons valued to about $150 million, consisting mainly of Undaria and Porphyra;
b) The International trade in seaweeds is worth more than 11 billion dollars a year;
c) There are nearly 21 seaweeds used in the daily food of Japanese an average of 4 kg/capita. There is a large industry built around the colloid compounds derived from seaweeds – Agar, Algin and Carragenan;
d) Alginates find their role in textile printing, in the paste containing the dye in order to maintain colour;
e) Seaweed extracts are used in the emulsion necessary for photographic industry.
f) Extracts from ashes of algae are used to make glass, soap and dyeing;
g) When we eat yoghurts, ice creams, milk shakes, instant custard tarts or jelly we eat seaweeds. When we brush our teeth, our tooth paste contains seaweed extracts;
7 CONCLUSION

Seaweeds or macro algae are rich in micronutrients with over 60 mineral elements, rich in Pro vitamin – A (carotene), protein 20 – 70%, Vitamin – C, Fibre – 32 -50 %, very little fat and most importantly with Vitamin B12 not found in land plants, have much more to talk about to their credit.

Ocean water is literally, the life blood of the plant, containing all essential nutrients in similar ratios to those in the mammalian blood stream and the sea wees as powerful collectors. They act as CO2 sinks and 70% of the oxygen is supplied by the seaweeds alone.

Seaweeds have shown their presence in almost every field related to health and food. In this era where there is shortage of fodder, space and pollution to fight, seaweeds form the best alternative for the food and health of animal husbandry.

Seaweeds can be grown in ocean and harvested from the natural stocks, without plundering the habitat to supply to the livestock, this does not have to compete for land space like terrestrial plants, a 3 fold production from seaweed can be obtained from the same space of land value in water. This will reduce the pressure on agricultural land, helping in restoration of land and combat climatic change.

Growing seaweeds requires no fertilizer and uses these from the seawater and gives back.

Saved is produced, nearly 40% of the production cost in animal husbandry goes to feeding and the other 40% to maintain animal health. Use of seaweeds in the food and health maintenance brings down the production cost by nearly 20 – 25 % which is substantial.

So, we conclude that seaweeds are a potential substitute for animal husbandry needs of food and health. They reduce the pressure on the earth in relation to the growth of plants and the rate of deforestation could lead to devastating conditions and animal perishing due to lack of food, seaweeds act as fodder and reduce the pressure on plants, the number of which is dwindling day after day. Seaweeds are eco-friendly doctors too.
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ANNEXES

1 GREEN ALGAE – CHLOROPHYCEAE

Figure 1 - Caulerpa – Food Alga
Source: original pictured by the author taken in Chennai

Figure 2 - Enteromorpha – Luxury Food
Source: original pictured by the author taken in Chennai

Figure 3 - Ulva Lactuca – Food Alga
Source: original pictured by the author taken in Chennai
2 RED ALGAE – RHODOPHYCEAE

Figure 4 - Porphyra – Nori Of Japan

Source: original pictured by the author taken in Chennai

Figure 5 - Gracillaria – Agar

Source: original pictured by the author taken in Chennai

Figure 6 - Gellidium-Agar

Source: original pictured by the author taken in Chennai

Figure 7 - Chondrus – Carragenan

Used to make soups jellies & as a remedy for respiratory disorders like Cold, Influenza and TB.
Source: original pictured by the author taken in Chennai
Figure 8 - Carollina – Carragenan
Secrets calcium carbonate out of the cell used in replacement therapy
Source: original pictured by the author taken in Chennai

3 BROWN ALGAE

Figure 9 - Laminaria – Algin And As Food
Source: original pictured by the author taken in Chennai

Figure 10 - Ascophyllum – Alginic Acid, As Food & In Biotechnology
Source: original pictured by the author taken in Chennai

Figure 11 - Sargassum – Algin In Microbiology
Source: original pictured by the author taken in Chennai
Figure 12 - Saccharina – Algin

Source: original pictured by the author taken in Chennai

Figure 13 - As Fertilizer & Soil Binder


Figure 14 - In Waste Water Treatment

Source: original pictured by the author taken in Chennai

Figure 15 - As Biomass For Fuel

4 AS HUMAN FOOD

Figure 16 - Nori

Figure 17 - Green Laver

Figure 18 - Kombu

Figure 19 - Wakame
Figure 20 - Dulse Served As Salty Cocktail Snack

Figure 21 - Irish Moss

Figure 22 - Blancmange – A Kind Of Pudding

Figure 23 - Green Caviar
5 AS COSMETIC

Figure 24 - Thalassotherapy

Source: original pictured by the author taken in Chennai

Figure 25 - Hydrotherapy Using Seaweeds


Figure 26 - As Animal Feed


Figure 27 - Growing And Harvesting Of Seaweeds