AN ANALYSIS OF MARKET POTENTIAL FOR SPIRULINA IN TAMILNADU

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CERTIFICATE

This is to certify that the thesis entitled "**AN ANALYSIS OF MARKET POTENTIAL FOR SPIRULINA IN TAMILNADU**" submitted in part fulfilment of the requirements for the award of the degree of **MASTER OF BUSINESS MANAGEMENT** to the Tamil Nadu Agricultural University, Coimbatore is a **bonafide** record of research work carried out by **Mr. C.R. VAIDYANATHAN** under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

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DEDICATED TO MY

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(C.R.VAIDYANATHAN)

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CHAPTER I

INTRODUCTION

Natural products are now being recognized for larger application after being in use for centuries in some parts of the world. Microbes have contributed significantly as an alternative food source. Till now, algae have been denigrated as polluters of water sources and smelly plants which are uncommenceble. The single-cell protein (SCP) is the main source of industrial protein from most microbes. This has been used mainly from Blue Green Algae and Yeast. Earlier efforts on Blue Green Algae as a food source have been directed towards Chlorella and Scenedesmus.

Recently spirulina, a microscopic Blue Green Algae is finding new possibilities as a food source. Spirulina was first discovered by Aztecs of ancient Mexico. They called it "*Tecui-tlatl*". It has also been a food to the Kanembou tribe of lake Chad in central Africa for centuries. These tribes called the sauce made out of Spirulina as "*Dihe*" (or) "*Douhe*"[1]. Later spirulina was rediscovered in the year 1964 by the French botanist Leonard[2].

Spirulina belongs to the family oscillatoriaceae of Cyanobacteria. It tends to grow in the alkaline waters in Africa, Asia, North and South America in latitudes between 35°S

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[1] Venkataraman, L.V., , **Spirulina in India** , Proc. Natl. Sem. 'cyanobacterial Research - Indian scene, NFMC - BARD, Trichy, 1993. pp.92-116.

[2] 'Spirulina', Youth Express-, "**The Indian Express**", Friday 11, October, 1996. p.7.

and 35°N and in areas of incident solar irradiation from 600-800 $KJCM^{-2}$ and total insolation from 3000 to 4000 hrs y^{-1}.[3]

Chemical composition of spray dried Spirulina is credited with world's richest source of protein and vegetarian source of vitamin B_{12}. (Table:1 and Figure. 1).

Table:1.- Composition of spray dried Spirulina (per 100 gm)

Major constituents			Minerals	
Protein	65-71	%	Calcium	658 mg
Fat	6.7	"	Phosphorous	977 ..
Crude fibre	9.3	"	Iron	47.7 ..
Carbohydrates	16.0	"	Sodium	796 ..
Calories	346		Potassium	1.14 ..
Vitamins			Essential Amino acids	
B-Carotene	320000	I.U	Lysine	2.99 %
Biotin	0.22	µg	Cystine	0.47 ..
Cyanocobalamine	65.7	,,	Methionine	1.38 ..
Folic acid	17.6	..	Phenyl alanine	2.87 ..
Other B-Complex Vitamins	9.2	,,	Threonine	3.04 ..
2-Tocopherol	0.73	I.U		

Source: Ripley D.Fox ,**Spirulina Production and Potential**, (NewYork:Bord &Frad Publishers, 1996), p.7.

It is a rich source of beta carotene (1.7g per Kg. dry matter) which is a precursor of vitamin A, and some type of linolinic acid that are not normally found in common dietary items. Its energy content is 346 K.cal per 100g and digestibility as high as 84 per cent with a net protein utilization level of 61 per cent[4].

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[3] Venkataraman, L.V., **Op. Cit.**, pp.92-116.

[4] **ibid.**

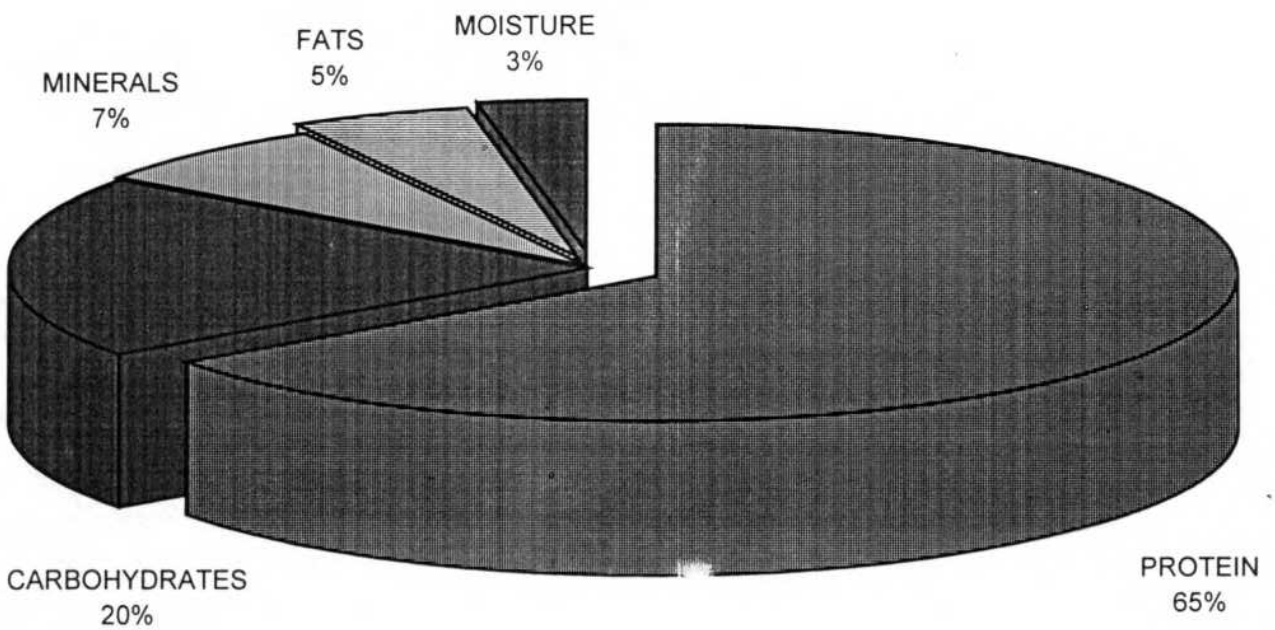

Fig.1 Composition of Spirulina

In Table: 2 and Table: 3 the Net Protein Utilisation and Beta Carotene content of Spirulina is compared with other sources. The Net Protein Utilisation (NPU)is about 40% next to whole dried egg and beta carotene content is highest compared with other natural sources. So it has been promoted as a health food and nutritional supplement in the last two decades all over the world.

Table: 2.- Protein content and quality for spirulina and other protein food sources (%)

Food	Protein	NPU	Usable Protein
Spirulina	65	62	40
Dried Eggs, Whole	47	94	44
Brewers Yeasts	45	50	23
Soya flour, Whole	37	61	23
Dried milk, Skim	36	82	30
Cheese. Parmesan	36	70	25
Wheat germ	27	67	18
Peanuts	26	36	10
Chicken	24	67	16
Fish	22	80	18
Beef	22	67	15
Sesame Seed	19	60	11
Oats, whole flour	15	66	10
Wheat, whole flour	14	63	9
Brown rice	8	60	5

Source: Switzer, Larry. **Spirulina-the whole food Revolution**, (New York: Bantam Books, 1982), p.21.

Note : % - by mass

NPU - Net Protein Utilisation

Table. 3.- Betacarotene in Spirulina and Vegetables

Food Source	Serving Size	IU of Beta carotene
Spirulina	1 heaping table spoon (10g)	23000
Papaya	1/2 medium	8867
Sweet Potato	1/2 cup, cooked	8500
Collard Greens	,,	7717
Carrot	,,	7250
Beet Greens	,,	6042
Spinach	,,	6000
Chlorella	50 tablets (10g)	5550
Watermelon	1 cup	1173
Peach	1 large	1042
Apricot	1 medium	892

Source: "Vegetarian Times", Recipes with A+ nutrition May 1986, p-47

Nearly 75 million Indian children below the age of five, suffer from malnutrition every year. This filamentous algae could be a possible solution to this chronic problem of malnutrition. Researchers find this alga irresistible. The 1974 World Health Organisation's food conference declared it "The best food for tomorrow"[5].

Spirulina has also been incorporated in medical formulation owing to its excellent natural composition and characteristic of no side effects or habit forming. It is used in therapeutic agents and has curative effects on patients suffering from pancreatis, hepatitis, and cirrhosis in curing glaucoma and cataracts, gastic ulcers, night-blindness, liver and circulation disorders: and in controlling anaemia. The high amount of essential

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[5] Spirulina'- Youth Express, "**The Indian Express** ", Friday 11, October 1996, p.7

polyunsaturated fatty acids in the form of Gamma Linolinic Acid (GLA) makes it amenable to lower cholesterol levels. It has also been used to increasing lactation in Vietnam and as a multi vitamin tablet in USA and Japan. In China and Korea, natural medicine is being blended with spirulina and exported. These spirulina formulations have found great acceptance in the US and Japan markets[6].

Spirulina being totally natural without side effects and vegetarian in its content can easily be incorporated in Ayurvedic medicines to produce more nutritive *lahias*, *arishtas* and *churanas*

Cosmeticians the world over have effectively utilized the high nutritive content of spirulina in the manufacture of anti-wrinkle cream, pimple cream, rejuvenating masks, face packs and biolipstics. Spirulina, is ideally suited to the manufacture of face cream and lotions which are basically formed of protein and a lubricant. These are the some applications of spirulina in Natural medicine.

Spirulina as a fish and livestock feed has potential to develop as a cottage industry using low-cost technologies. Studies conducted at Central Institute of Freshwater Aquaculture [CIFA] at Bhubaneshwar, Orissa have shown that carp fry fed with a mixture of rice bran and groundnut oil cake in equal proportion and 10 per cent powdered spirulina grew faster than the one, fed with rice bran and groundnut oil cake alone. Catla, rohu, mrigal, grass carp and common carp registered significantly higher growth rates, according to the scientists. The spirulina incorporated diets also enhanced disease resistance and organoleptic qualities of fishes. For prawn and shrimp larvae, spirulina based feeds reduced larvae mortality and gave a good growth rate. Breeders of ornamental fish can use spirulina to obtain better colouring.

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[6] Venkataraman, L.V., **Op.Cit.,** pp. 92-116.

Spirulina as a poultry feed has shown an improved growth rate in both broilers and layers. Egg laying commences by the 20th week in layers. and there is improved shell-thickness. The colour of yolk is deep yellow due to the presence of beta-carotene in spirulina and this is preferred by consumers.

The resource requirements of spirulina vis-à-vis other protein suppliers are presented in Table 4 through 7 below.

Table- 4.-Water needed to produce one kilogram of protein (in litres)

SL.NO.	Source	Litres	Quality
1.	Spirulina	13638	Brackish
2.	Soybean	48353	Fresh
3.	Corn	67776	Fresh
4.	Grain-fed beef	568250	Fresh

Source: Henrikson Robert,` **Earthfood spirulina**`,(California:Ronore Enterprices Inc.,1989),p-119

Table-5.- Land area needed to produce one kilogram of protein (in Sq.m.)

SL.NO.	Source	Square Meters	Quality
1.	Spirulina	1.0	Non-fertile
2.	Soybean	16.0	Fertile
3.	Corn	22.0	Fertile
4.	Grain-fed beef	193.0	Fertile

Source: Henrikson Robert,` **Earthfood spirulina**`,(California:Ronore Enterprices Inc.,1989),p-118

Table-6.-Energy Efficiency (million k. joules per kilogram of product)

SL.NO.	Source	Total Energy Input	Total Energy Output	Energy Output/Input
1.	Spirulina	5.5	23.0	4.2
2.	Soybean	11.7	13.8	1.2
3.	Corn	5.5	16.5	3.0
4.	Grain-fed beef	456	16.0	.04

Source: Henrikson Robert,` **Earthfood spirulina**`,(California:Ronore Enterprises Inc.,1989),p-119

Table-7.- Protein Productivity Comparison (tons/hectare/year)

SL.NO.	Source	Protein Productivity
1.	Spirulina	50.0
2.	Sugarcane	3.00
3.	Soybean	2.50
4.	Corn	2.00
5.	Wheat	0.80
6.	Rice	0.20
7.	Beef Cattle	0.16

Source: Henrikson Robert,` **Earthfood spirulina**`,(California:Ronore Enterprises Inc.,1989),p-118

As could be seen in the table 4, spirulina requires less amount of water 13638 liters compared to other proteinaceous crop requirements . In Table:5, it could be seen that spirulina requires less land area of 1 m^2 . But its energy efficiency is as high as 4.2 (vide Table.6) compared to other sources. For the use of relatively less water and land and with higher energy used, protein content of Spirulina is highest at 50 t ha^{-1} y^{-1} compared to others (vide Table .7)

Over forty countries are already producing spirulina at different levels and the annual global production is around 1500 tpa. Details are presented in Table: 8. Spirulina is primarily used in medicines and healthcare. Major species cultivated for commercial production are, *Spirulina maxima, S.fusiformis and S.platensis*. Major producer of this wonder algae are Japan, US, Thaiwan, China and Thailand. During the last decade, India has entered into production with the annual production of 70-100 tpa. This is stated to increase to about 200 tonnes in next three years. Spirulina is sold at about Rs.750/= per Kg in India and the international price varies between US $ 15-20 per kg[7].

Commercialization of spirulina in India started with Dr.C.V.Seshadris Murugappa Chettiar Research Centre, Chennai starting the New Ambadi Estates Pvt. Ltd. at Sevariarpuram, Pudukottai District in 1986. A host of industries now produce spirulina. Important among them are:

1. New Ambadi Estates Pvt.Ltd., Sevariarpuram, Pudukottai District.
2. Ballarpur Industries Ltd (Bilt), Nanjangude, Mysore.
3. Parackal Form Pvt.Ltd, Arcot, Maduranthakam.
4. Cyanotech Bioproducts Ltd., Bangalore

Dabur is expected to start its own production unit near Dindigul. International brands in the fray are Mecosane Spirulim (Dutch), Spirulina - Marcus Rohrer (Europe), GD-1 (Thai), Spir-all (Cuban), Life-stream spirulina, Super blue green - Alpha sun, Blue Green Manne (USA), Lactogil, Linevina (Vietnam).

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[7] Venkataraman, L.V., **Op.Cit.,** pp.92-116

Table.8.-Global production of Spirulina (tonnes per annum)

Producer	Locality	Quantity
Earthrise Farms	Calipatria, California	225
Cyanotech Corp.	Keahole Point, Hawaii	250
Siam Algae Co.	Bangkok, Thailand	80
Far East Microalgae	Taiwan	25
Nan Pau Chemicals	Taiwan	25
Blue Continent	Taiwan	25
Tung Hai	Taiwan	25
Solarium	Iquique, Chile	20
Binor	La Serena, Chile	20
Vinh Hoa	Thuanhai, Vietnam	15
Cyanotech Ltd.	Bangalore, India	15
Green Diamond	Chaing Mai, Thailand	10
Parry Agro Ltd.	Tamil Nadu, India	10
Ballarpur Industries	Mysore, India	50
Unisys	Kaomua, Hawaii	10
Government Farms	Habana, Cuba	20
Government Farms	Myanmar	30
	Ukraine	20
Imade	Granada, Spain	10
Sourigues Strembel	Rosario, Argentina	15
	Hainan Island, China	100
	Nanchang, China	50
	Wuhan, China	100
Total		1150

Source: Fox D. Ripley, **Spirulina: Production and Potential** (Paris:Edisud,1996).p-38

Problem statement

Coming years will see a large expansion of spirulina in India and abroad with increase in the range of products. India has to gain a lot in the use of this alga for making it available at affordable prices in the market. There is a great scope to exploit its production at rural level with small capital inputs. which can provide employment. India has an unique place in Spirulina as it has pioneered the technology development though lagged behind in its exploitation.

With this background in mind it was felt necessary that a market potential study for spirulina powder would be of great use to upcoming industries. entrepreneurs and researchers in the area.

Objectives :

Overall objective of study is to assess the market potential for spirulina in Tamil Nadu and to identify ways for product promotion. Specific objectives are:

(i) to estimate the demand for Spirulina as a source of raw material for pharmaceutical products and animal feed in Tamil Nadu state;

(ii) to identify the factors determining the demand for and supply of spirulina powder;

(iii) to find the market feasibility for spirulina in Tamil Nadu;

(iv) to formulate a suitable market entry strategy; and,

(v) to calculate the cost of production and return on investments for spirulina powder.

Hypothesis:

Above objectives imply that there is vast scope for spirulina in the market. especially as a source of protein in pharmaceuticals and animal feed and this could be met by expansion in production which is economically viable. But expansion of production depends upon the size of market. Therefore an appropriate promotional strategy is the key for the success of spirulina producing firms. This is the hypothesis to be empirically tested by this study.

Scope of the study

This study attempts to know the extent of use of spirulina as a source of protein in animal feed industry and pharmaceutical industry and the cost of acquiring the single-cell protein which can be substituted for the other source of protein. The extent of substitution rate will give an idea of the importance of the production of spirulina. Moreover as this study is suggested by SIV industries who have plans to start a production plant the findings of this study, especially the economics of production of spirulina will be useful to them.

Limitation

Due to time constraint, the study was confined to a limited geographical area. Even though efforts were taken to collect the data, some of the companies did not reveal full information. However sincere efforts were taken to collect all possible data regarding spirulina. The findings of the study may be considered appropriate to the situation prevailing in the study area and especially useful to the case firm. However extra care should be taken while making generalisation.

Organisation of the thesis

The thesis is organised into six chapters as follows:

Chapter I : The introduction, objectives, scope and limitation of the study are discussed.

Chapter II : Concepts used in the present study and some of the concept used earlier by other workers are discussed.

Chapter III : This chapter explains the sampling design, method of data collection and tools used in the conduct of research and analysis of data.

Chapter IV : The general and demographic characteristics feature of the study region are described.

Chapter V : The results of the analysis are presented and discussed to draw inferences with respect to the objectives.

Chapter VI : A summary of the results of the study are presented to draw specific conclusion and policy implication.

CONCEPTS AND REVIEW

CHAPTER-II

CONCEPTS AND REVIEW

Economic analysis of any problem involves conceptualization of various issues considered in the study. A review of past studies would help in conceptualizing issues relevant to the study. A brief review of past studies related to the present study is presented in this chapter. The study is concerned with the market potential for spirulina, as a intermediary product to be used in pharmaceutical formulations and animal feed. Therefore the concepts of market, marketing, market demand and market potential are important. They are reviewed first and then precisely defined for their use in the present study.

CONCEPTS

Market

The word market is derived from the Latin word '*marcatus*' which referred to merchandise or place where business was conducted. Thus the market referred to a place or the actual forces that resulted in the exchange of goods from one hand to other.[1].

Nair *et al.*, defined market as people with needs to satisfy and money to spend for it.[2]

Cundiff and Still defined market as the aggregate of forces or conditions within which buyers and sellers make decisions that result in transfer of goods and service and determination of prices i.e., value in exchange.[3].

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[1]R.D. Tousely, E. Clark and E.E. Clark, **Principles of Marketing** (London : The Mac Millan Company Inc., 1962), p.15

[2]K.N. Nair, Paul John and W.George, **Marketing and Sales Promotion.** (Delhi : Himalays Publishing House, 1986), p.5.

[3]E.W. Cundiff and R.R. Still, **Basic Marketing**, (New Delhi : Prentice Hall India Pvt.Ltd., 1986), p.21.

According to Backman and Davidson market is a sphere within which price making forces operate and in which exchanges of title tend to be accompanied by actual movement of the goods affected. They considered that "market is the place of action for the price making factors'[4]

Stanton defined market as a concentration of people with needs to be satisfied, money to spend and willingness to spend on it.[5] This definition placed emphasis more on demand forces while in fact the supply side also was as much important.

A market consisted of all the potential customers sharing a particular need or want and might be willing and able to engage in exchange to satisfy that need or want.[6] This definition was again incomplete because it failed to place supply side forces in proper perspective.

A market has two forces with interests conflicting each other namely buyers and sellers and their interaction was the goal to be served by the market . Therefore a market is defined for the present study as a place or arrangement wherein buyers and sellers of a good or service interact to exchange information, with the view to agreeing for prices for the transfer of title to the good or service from seller to the buyer. Any arrangement for formal or informal, spatial, temporal or socio-temporal activities leading to the exchange of goods or services and determination of prices is a market. The process of exchange itself is called marketing.

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[4]Backman and Davidson, **Marketing**, (New York : Ronald Press Company, 1973), p.4.

[5]Willium J. Stanton, **Fundamentals of Marketing**, (New Delhi : Mc Graw Hill Book Company, 1984), p.74.

[6]Philip Kotler, **Marketing Management**, (New Delhi : Prentice Hall of India Ltd., 1994), p.15.

Marketing

According to American Marketing Association, marketing has been referred as the performance of business activities that would direct the flow of goods and services from the producer to the ultimate consumer or user.[7] It is then a process and involves transfer of title of goods from one to another in a series until it is in the hands of ultimate customer.

Pyle thought that of marketing as the phase of business activity through which human wants are satisfied by the exchange of goods and services on the one hand and for some valuable consideration, valuable consideration, usually money or its equivalent on the other.[8]

Kohls defined marketing as all such activities which are involved in moving the product from the firm to the consumer and related to all business activities involved in the flow of goods and services from the point of initial production until they were in the hand of the ultimate consumer.[9]

Stanton defined marketing as the total system of activities designed to plan. price. promote and distribute want-satisfying goods and services to the users.[10]

Kotler viewed marketing as a managerial and social function.

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[7]R.D.Bazzel, J.B. Mathews Jr. and T. Levitt Quoting American Marketing Association in Marketing, **An introductory analysis**, (New Delhi : McGraw Hill Book Company Inc., 1974), p.13.

[8]J.F.Pyle, **Marketing Principles**, (New York : Mc Graw Hill Book Company, 1956), pp.24-25.

[9]Richard L.Kohls, **Marketing of Agricultural Products**, (New York : The Mac Millan Company, 1967), p.9.

[10]Willium J.Stanton, **Fundamentals of Marketing**, (Singapore McGraw Hill International Book Co., 1987), p.73.

According to managerial function, it is the process of planning and executing the conception, pricing, promotion and ideas to create exchanges with target group to satisfy customer and organisational objectives. According to social function, it is the process by which individuals and group obtain what they need and want through creating and exchanging products and value with others.[11]

Subramaniyan *et al.* referred marketing to the process of defining, anticipating and creating customer needs and wants and organising all the resources of the company to satisfy them.[12]This looks marketing as an activity of a firm. The collection of similar activities by all the firms is marketing from the social point of view.

Bishwambhar considered the marketing concept to have a management orientation. The task of the organisation is to determine the needs and wants to target market, and to adopt the organisation to deliver the desired satisfaction more effectively and efficiently than its competitor[13]. Thus marketing was restricted to business decisions concerning sales of products.

Sherlehar considered that marketing is an ongoing process. He defined marketing as an ongoing process of discovering and translating consumer needs and services, creating demand for those products and services, serving the consumer demand with the help of marketing channel [14].

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[11]Philip Kotler,**Op.cit.,** p.13.

[12]G. Subramanium, A. Ramakrishna and S.K. Prasad, "Hand book on Marketing - A study of consumer behaviour", **Indian Journal of Marketing**, 20(6) : 12, 1985.

[13]L. Bishwambhar, "Values orientation in Marketing Management", **Indian Journal of Marketing**, 27(1) : 21-22, 1986.

[14]S.A. Sherlehar, **Marketing Management** (Bombay : Himalayan Publication House, 1983), pp.7-8.

According to Dubey, marketing is the function which assesses the consumer needs, and then satisfies them by creating an effective demand for goods and services at a profit.[15] In this definition the word function refers to a set of business activities interrelated to each other.

Above definitions suggest that (1) marketing is all such business activities done between production and ultimate consumption/use. It begins when the good / service first changes hand and ends when the ultimate user acquires it, for immediate, or future use. The travel of the good / service may be long or short and hence may involve one or more exchanges. The concept of marketing refers to the total of such exchanges. This is the concept of marketing used in the study. Given the concepts of market and marketing the focus shifts to the concept of market potential. Which however, needs first the concepts of market demand and market share.

Market Demand

According to Kotler, market demand for a product is the total volume that would be brought by a defined customer group in a defined geographical area in a defined time period in a defined marketing environment under a defined marketing program.[16]

According to Bach, demand is the schedule of amounts of any product that buyers will purchase at different prices during some stated time period.[17]

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[15]V.K. Dubey, **Perspectives in Rural Management**, Vol.2, (New Delhi : Commonwealth Publishers, 1991), p.288.

[16]Philip Kotler,**Op. cit.,** p.259.

[17]George Lenald Bach, **Economics : An Introduction to analysis and policy**, (New Delhi : Prentice Hall of India Pvt.Ltd., 1982), p.41.

Obviously in a market with several buyers the market demand would therefore refer to the sum of quantities demanded by all the buyers at different prices. In technical term the market demand is the horizontal summation of individual demand curves.

The market demand would therefore show the maximum amount that could be sold at a price and as price varies this amount varies too, but in opposite direction. It is the demand faced by all the sellers in the market. For individual sellers (firms) this total is shared, depending upon their market power. That share is simply called firms market share.

Market share

The percentage of a market controlled by a certain company product or service is defined as market share.[18]

Wallace defined market share as that proportion of a market which prefers to buy a company's product.[19]

One Company's percentage share of the total industry sales in a given market is known as market share, according to Stanton[20] and also Kotler[21].

It should be noted that market share was the proportion of actual (realised) sales of the firm to the total sales in the market. However, the total market sales might be less than the total sales possible.

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[18]Loais E.Boone, and David L.Kurthy,**Contemporary Business** (New York : Dryden Press, 1982), p.314

[19]Michael J. Wallace and Patric J.Flynn, **Dictionary of Business English**, (Calcutta : Rupa and Co., 1984), p.100.

[20]Willium J.Stanton,**Op. cit.,** p.670.

[21]Philip Kotler,**Op.cit.,** p.712.

Market Potential

Rachman considered market potential as the plan for making marketing objectives that includes specifications of the target market and design of the mix of elements that would satisfy the target customers needs[22].

Evans stated that the market potential represented the maximum industry sales for a specific product or service to a specific consumer group over a specific period of time under a well defined level of marketing activity[23].

Dale considered market potential as the maximum sales of a product that could be achieved per time period for a specified environment and a specified marketing effort[24].

Davar meant marketing potential as the calculation of maximum sales opportunities for all sellers of a good or service during a stated period[25].

Stanton defined market potential as the total expected industry sales for a product in a given market over a certain time period[26].

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[22]David J. Rachman, **Modern Marketing**, (Illinois : The Dryden press Publishers. 1980), p.636.

[23]Joc R.Evans and Barry Berman, **Marketing** (New York : Mac Publishing Co. Inc.. 1982), p.27.

[24]Dale Litter, **Marketing and Product development**, (India : Heritage Publishers. 1985), p.252.

[25]Davar, **Modern Marketing Management**,(Bombay : Progressive corporation Pvt.Ltd.. 1975), p.273.

[26]Willium J.Stanton, **Fundamental of Marketing**, (Japan : McGraw Hill Book Company. 1980), p.670.

According to Kotler, total market potential is the maximum amount of sales (in units or dollars) that might be available to all the firms in an industry during a given period under a given level of industry marketing effort and given environment condition[27].

Ramasamy and Namakumari referred market potential in terms of demand and viewed it as nothing but a quantitative estimate of the total possible sales by all the firm selling the product in a given market[28].

Thus market potential refers to the possible sales of an industry. It referred to what would be possible ex anti whereas the actual sales referred to the potential actually realized.

The total realized (actual) sales of the industry is contributed by several firms contributing to it and the percentage of sales of a firm to the total sales of all the firms (industry) is therefore a measure of the firms market share.

The industry would aim at bridging the gap between the potential (possible) sales and the realised (actual) sales. When achieved sales of individual firms might increase by how much? The answer depended upon the relative strength of the firm vis-a-vis its competitors in the market. The firms gain their strength through marketing promotion.

Marketing Promotion

Promotion was a generic term used in marketing to denote all the methods adopted for persuasive communication. It would help to convert a potential buyer into actual buyer[29].

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[27]Philip Kotler, **op.cit.,** p.264.

[28]V.S.Ramasamy and Namakumari, **Marketing Management**, (New Delhi : G. Wasani Mac Millan India Ltd., 1990), p.160.

[29]P.K.Vijayachandran (FACT), Lecture delivered at FAI Southern Regional Training programme conducted in Trivandrum on 12th October, 1981.

Stanton referred promotion as an exercise in information persuation, presentation and communication. These three were related, because to inform was to persuade and conversely a person who was persuaded was also being informed. And persuation and information became effective through some form of communication[30].

Kotler referred marketing communication mix, (also called the promotion mix), to four major viz., Advertising, Sales Promotion, publicity and personnel selling[31].

Marketing Strategy

Kotler defined marketing strategy as the broad principles by which the business unit expects to achieve its marketing objectives in target marke·. It consists of basic decision on total marketing expenditure, marketing mix and marketing allocation[32].

Marketing strategy is a broad, basic plan of action by which an organisation intends to reach one or more goals[33].

According to cannon, strategy showed overall directions that the firm will adopt to achieve its purposes or objectives. A clear and communicable strategy statement can play a major part in facilitating the evaluation of tactics[34]

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[30]Willium J.Stanton,**Op.cit.,** p.341

[31]Philip Kotler,**Op.cit.,** pp.428-429.

[32]Philip Kotler,**Op.cit.,** p.71.

[33]W.J. Stanton. **Op.cit.,**, p.67.

[34]T. Cannon. **Op.cit.,**, p.344.

Evans considered that marketing strategy was the selection of a consumer market, marketing objectives, marketing organisation, marketing plan and control[35].

Product

Cundiff defined the product an overall inclusive term, that includes services as well as physical product goods a bundle of utilities constituting of product features and accompanying service[36].

Cannon referred product as any thing that can be offered to a market for attention, acquition or consumption, including physical objects, service, personalities, organization and desires[37].

Bagozzi considered product as a bundle of characteristics offered by one party, the seller to the another party, the buyer[38].

Bellur and Berkman, defined the product as some thing which satisfies the potential customers not only the physical/tangible, but also anything else that brings satisfaction to the customers[39].

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[35]Joe R. Evans and Barry Besman, **Marketing** (New York : MacMillan Publishing Co., Inc., 1982), p.27

[36]Edward, W. Cundiff, **Fundamentals of Modern Marketing**, (New Delhi : Prentice Hall of India Pvt. Ltd., 1985), p.104.

[37]T. Cannon, **Basic Marketing** (New York : Half Rinchart and Winston Ltd., 1986), p.225.

[38]R.P. Bagozzi, **Principles of Management**, (Chicago : Swance Associates Inc., 1986), p.137.

[39]I. Bellur and J. Berkman, **Readings in Marketing Management**, (Delhi : Himalaya Publishing House, 1987), p.155.

According to Kotler, the product concept holds that consumer will favour those products that offer the most quality performance and feature. Managers in these product oriented organization focus their energy or making good product and improving over time[40].

Product positioning

Cundiff defined the product positioning as the collective perceptive that consumer or users have of a company and/or its product in relationship to other companies and product[41].

Kotler defined product positioning as the act of designing the company's image, so that the segments customers understand and appreciate what the company stands for in relation to its competitors[42].

Place

Kotler, considered place as the various activities that the company undertakes to make the product easily accessible and available to target consumers. At last companies must identify, recruit and link various middle men and marketing facilitation, so that its products and service are efficiently supplied to the target market[43].

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[40]Philip Kotler, **Op.cit.,**, p.14.

[41]Edward Cundiff, **Op.cit.,**, p.369.

[42]Philip Kotler, **Op.cit.,**, p.308.

[43]Philip Kotler, **Op.cit.,**, p.74.

Price

Evans defined the price as the value of a product or service for both the seller and the buyer[44].

Kotler defined price as the amount of money that customers have to pay for the product[45].

Promotion

Vijayalaxmi considered advertising as a dynamic process by which the advertiser communicates about his product/service to the customers/perspective buyers[46].

Marketing Mix

Marketing mix is the set of marketing tools that the firm uses to pursue its marketing objectives in the target market[47].

A combination of the four elements - product, pricing structure, distribution system, promotional activities that constitute the core of an organization marketing system[48].

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[44]Joe R. Evans and Barry Berman, **Marketing** (New York : MacMillan Publishing Co., Inc., 1982), p.27.

[45]Philip Kotler, **Op.cit.,** p.74

[46]M.Vijayalaxmi, "Television - An effective medium of Advertising", **Indian Journal of marketing**, 19(8-9-10) : 25-27, 1989.

[47]Philip Kotler, **Marketing Management**, (New Delhi : Prentice Hall of India Private Limited, 1996), p.98.

[48]Willium J. Stanton, **Fundamentals of Marketing**, (Singapore : McGraw Hill Book co. 1987), p.648.

Marketing Cost Analysis

A detailed study of the operating expense section of a company's profit and loss statement[49].

Marketing Cost

According to Jain. marketing cost was the actual expenses required to bring goods and services from producer to consumer[50].

Kulkarni stated that marketing cost would normally include handling charges at local point. assembling charge, transport. handling by whole sales and retailing charges to consumer[51].

Dull and Gangwar defined marketing cost as the actual cost incurred by each agency involved in marketing channel for performing their functions. This included transportation. loading and unloading. weighing, cleaning, octroi. market fee. commission cost and wastage[52].

Investment costs

Investment costs are defined as the sum of fixed capital and net working capital[53]. Fixed capital includes fixed investments and pre production capital costs.

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[49]Willium J. Stanton, **Op.cit.,** p.648

[50]S.C. Jain, **Principles and practices of Agricultural Marketing and Price Policies.** (Bombay : Vora and Comp. Publishers Pvt. Ltd., 1971), p.8.

[51]K.R. Kulkarni, **Agricultural Marketing in India.** (Bombay : Cooperators Book Depot., 1974), p.380

[52]D.N. Dull and A.C. Gangwar, "Marketing of Rape seed and Mustard in Haryana". **Agricultural Marketing.** 18(1): h16. 1975.

[53]Anonymous. "Manual for the preparation of industrial feasibility studies". **Op.cit.,**. p.153

Fixed capital constitutes the resources required for constructing and equipping an investment project.

Fixed investments should include the following,

a) Land and site preparation;
b) Building and civic works;
c) Plant, machinery and equipment including auxillary equipment and
d) Certain incorporated fixed assets such as industrial property rights.

Fixed Cost

A constant cost regardless of how many items are produced or sold[54]

According to Snodgrass and Wallace, fixed costs were those costs that did not change as output changed[55].

Wonnacott and Wonnacott defined fixed cost as that cost that did not vary with output[56].

Fixed costs are costs that do not vary with production or sales revenue[57].

Vanisckle and Rogge defined fixed costs per time period as the sum of costs of fixed inputs like land, building, machinery, management etc.[58]

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[54]Willium J. Stanton, **Op.cit.,**, p.646.

[55]Milton M. Snodgrass and L.T. Wallace, **Agriculture, Economics and Resource Management**, 2nd ed. (New Delhi : Prentice Hall of India Private Limited, 1982), p.200.

[56]Poul Wonnacott and Ronald Wonnacott, **Economics**, 2nd Ed. (Tokyo, McGraw - Hill International Book Company, 1984), p.829.

[57]Philip Kotler, **Op.cit.**, p.496.

[58]John V. Vansickle and Benjam, A. Rogge, **An Introduction to Economics**, (New Jersey : Princeton, 1968), p.106.

Singh and Satish included the rent, depreciation, and interest on building and machinery and salaries to the staff[59].

Varma and Agarwal expanded this concept and described fixed cost as one which did not change with a change in volume but vary per unit of volume inversely[60].

Variable cost

Snodgrass and Wallace defined variable cost as those directly related to production output[61].

According to Wonnacott and Wonnacott, variable costs were those costs which increased as output increment[62].

Variable costs vary directly with the level of production. These costs, tend to be constant per unit produced and their total varies with the number of units produced[63].

Dewett defined variable cost as one which varied with level of output. It included cost of raw material used, cost incurred in marketing of commodity as well as the cost of casual or daily labour employed. It was incurred only when the firm was at work[64]

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[59]Rajvar Singh and K.S. Satish, "Cost Analysis of Toned Milk Processing", **Indian Journal of Agricultural Economics**, 34(3): 61-65, 1979.

[60]M.M. Varma and R.K. Agarwal, **Managerial Economics**, (New Delhi : Forward BookDept, 1992), p.64.

[61]Milton M. Snodgrass and L.T. Wallace, **Op.cit.,**, p.201.

[62]Paul Wonnacott and Ronald Wonnacott, **Op.cit.,**, p.407.

[63]Philip Kotler, **Op.cit.,**, p.496

[64]K.K. Dewett, **Modern Economic Theory**, (New Delhi : Shyam Lal Charitable Trust, 1969), p.196.

Ahuja more explicity defined those costs which were incurred on the employment of variable factors of production whose amount could be altered in short run[65].

Varma and Agarwal referred variable costs as one which should have linear relationship with production [66].

A cost that varies or changes directly in relation to the number of units produced or sold[67].

Total Cost

The sum of total fixed costs and total variable cost or the full cost of a specific quantity produced or sold[68].

Total costs were the sum of fixed costs and variable costs[69].

Total costs consists of the sum of the fixed and variable costs for any given level of production[70].

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[65]Ahuja, **Op.cit.,** p.330.

[66]M.M. Varma and R.K. Agarwal, **Op.cit.,,** p.64.

[67]W illium J. Stanton, **Op.cit.,,** p.654.

[68]Willium J. Stanton, **Op.cit.,,** p.653.

69Paul Wonnacott and Ronald Wonnacott. **Op.cit.,** p.407

[70]Philip Kotler. **Op.cit.,,** p.496.

Net Return

Singh calculated the net return by deducting the variable cost from the gross income[71].

Break even point

The level of output at which revenues equal costs[72].

Break-even analysis

The break-even point or break even quantity is that level of production and sales at which total revenue is exactly equal to total operating cost. Break even analysis tells the manager how profits will vary when production costs, sales revenue and selling price vary. That is why it is called cost-volume-profit analysis [73].

Technology know how

Ahuja opines that the technological know how should be available near sources, so that delay in consultation will be reduced if any breakdown or troubles occur in the plant[74].

REVIEW OF PAST STUDIES

Micro algae spirulina and some strains of yeasts which yield high quantities of protein have been tried for single-cell protein(scp) production. There are inherent

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[71]Katwar Singh, "The Impact of new Agricultural Technology on Farm Income Distribution in Aligarh District of Uttar Pradesh", **Indian Journal of Agricultural Economics**: 28(2), 11, 1973

[72]Willium J. Stanton, **op.cit.**, p.643

[73]Ramesh K.S.Rao, **Op.cit.,** p.253.

[74]K.K. Ahuja, Production Management, (Delhi : CBS Publishers (P) Ltd., 1983), p.13..

problems of high nucleic acid content in the yeasts. SCP has not picked up well due to acceptability, safely and cost considerations[75].

Studies conducted at the Central Institute of Freshwater Aquaculture (CIFA) at Bubaneshwar in Orissa have shown that carp fry fed with a mixture of rice bran and groundnut oil cake in equal proportion and 10 percent spirulina grew faster than the ones fed with rice bran and groundnut oil cake alone. Catla, rohu, mrigal, grass carp and common carp registered significantly higher growth rate according to the scientists[76].

Spirulina, may be India's solution to the problem arising from malnutrition. A little helping of the alga may nourish nearly 75 million malnourished children below the age of five years. For one kg of spirulina packs the nutrition of 100 kg of vegetables [77]. Two species of spirulina were cultivated in outdoor ponds using low-cost substrates for some of the recommended nutrients. In particular, bone meal and biogas effluent were found to be very effective for the growth of these species[78].

Farrer and Ortega stated that the blue green algae spirulina was eaten in Mexico under the names Tecuillatle, Cocol, Cocolin or Amomoxtle in the past and are still being consumed in Mexico along with other blue green algae[79].

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[75]G.A. Ravishankar and L.V. Venkataraman, 'Application of Genetic Engineering in food Biotechnology',Microbian Gene Technology, H.Palasa (Editor), (New Delhi : South Asia Publisher,1991), p.191.

[76]The Hindu Science & Technology, Thursday 14, September 1996, p.28. vegetables[77].

[77]Indian Express - Youth Express "Science & Nature", Friday 11, October 1996, p.7.

[78]C.V. Seshadri and Sebastian Thomas, "Mass culture of spirulina using low-cost nutrients", Shri A.M.M.Murugappa Chettiar Research Centre, Taramani, Chennai 600 042, India.

[79]Ferrer and Ortega, M.M., Revete Lat. Am. Microbiol., 14(1): 85, 1972.

Venkataraman found that the unicellular algae are the smallest and simplest photosynthetic apparatus for effective utilization of plentiful solar energy[80].

Leonard and Compere found that the blue green algae spirulina is collected and eaten by natives around lake T chad in Africa traditionally[81].

Chastel and Clement found that Sosa Texcoco has steadily developed the production of spirulina meal and reached a daily output of 2 tonnes. The product is exported in appreciable amounts to Japan and other countries. Thus, Sosa Texcoco is today the leading enterprise for spirulina production[82].

Lipinski and Litchfield found that Spirulina maxima in the substrate of nutrient mix + bicarbonate has total nitrogen of 9.9% and crude protein (N x 6.25) of 60 percent on dry weight basis[83].

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80 L.V. Venkataraman, (1978), 'Photosynthetic productivity in mass outdoor culture of algae', Proceedings of International symposium on Biological application of Solar energy', held at Madurai,India.

81. J. Leonard, and P. Compere,'Spirulina plantensis (Gen.) (Geitt, 1967). Algue bleve de Grande valuers Alimentaire par sa Richesse en Proteines, Bull.Jard. Bot. Nat.Belg.37 (suppl):1.

82H. Durand-Chastel and G. Clement, (1975). 'Spiruline-algae the food for tomorrow'. Proceedings of 9th Congress Nutrition, Mexico, 3 : 85.

83E.S. Lipinski and J.H. Litchfield, CRC Critical Review in food technology, 2895) : 16. (1974).

Shelef and Soeder described that algal biomass can be used as food and feed for animal husbandry, fish and aquaculture human nutrition and human health food[84].

The technology of spirulina developed by CFTRI, Mysore. Spirulina is produced by totally indigenous and completely developed by low-cost technology with no inputs of electrical energy with complete elimination of capital intensive equipments. Presently the spirulina produced for its proteins is considered as a poultry feed and will substitute the groundnut protein or fish meal. [85]

Venkataraman and Becker has done considerable work to cultivate and process clean water algae especially the blue green algae spirulina. [86]

Tamiya and Oswald made a pioneering work on algal production technology which paved the way for further developments. [87]

Bourges *et al.* evaluated the protein digestibility of spirulina (drum dried) as 83.0. protein efficiency ratio (PER-2.5) as 1.80 and biological value (BV) 75.0.[88]

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[84]G. Shelf and C.J. Soeder, (Editors) Algae Biomass, (North-Holland : Elsiever Biomedical Press, 1980), p.9.

[85]Balbir S. Yadav, 'Single cell protein', (Unpublished Ph.D. thesis to Central Food Technological Research Institute, 1973, Mysore). p.25.

[86]L.V. Venkataraman and E.W. Becker, **Algal technology and its utilization.** (Mysore : CFTRI press, DST, 1986), p.25.

[87]H. Tamiya and W.J. Oswald, (1963) " Developmental Industrial Microbiology, 4(1) : 112,1963.

[88] M. Bourges, A. Sotomayor, E. Mendoza and A. Clevez, Nutrition. Rep. International. 4(1) : 31,1971.

Soeder in his study explained this way : The past and present utilization of microalgae for nutritional purposes is considered in general. Autotrophically produced microalgae are still relatively expensive and their use is constricted to a few special applications. Having about the highest biological value of all protein carriers of plant origin, their wider use for human consumption require as yet a more complete proof of their toxicological safety. Sewage grown microalgae have the potential of becoming an inexpensive proteinaceous product for animal nutrition, provided that their use does not pose intolerable health hazards. It is pointed out that the future development of the utilization of microalgae will also depend on technical improvements. [89]

According to chastel, Blue green algae of the genus spirulina have found worldwide interest as photosynthetic planktonic organism suitable for mass production. the historic utilization of spirulina as human food ingredient in Mexico and in the lake Tchad region is reviewed as well as modern activities of the same trait. Today the industrial plants for spirulina production are in operation in East Asia, Southeast Asia and especially in Mexico. Simplified technologies for spirulina production have been developed to be used at the village level in rural India. Details of chemical composition of Mexican spirulina and data concerning its nutritional properties are summarized below. It is believed that spirulina, because of its many favourable has great future potential in improving the protein supply to mankind particularly in warmer countries[90].

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[89]C.J. Soeder, **'The scope of microalgae for food and feed', Algal biomass : Production and use**, Cedaliah Shelef and Cart J. Soeda (Eds) (North Holland : Elsevier), pp.9-20, 1980.

[90]Duran, H. Chastel; **'Production and use of spiruline in Mexico', Algal Biomass : Production and use**. Gedaliash Shellf and Carl. J. Soeder (Eds), (North Holland : Elsevier, 1980),p.51-64.

Physical properties

Appearance	-	Fine powder
Colour	-	Dark green
Odour & taste	-	mild, resembling sea vegetables
Bulk density	-	0.5 g/l
Particle six	-	9 to 25 microns
Shape	-	Helical trichomes

Chemical composition :

	Minimum (%)	Maximum (%)
Moisture	4.0	7.0
Ash	6.4	9.0
Protein	60.0	71.0
Crude fibre	0.1	0.9
Xanthophylls	1.4 g/kg of the product	1.8 g/kg of the product
ß-carotene	1.5 g/kg of the product	1.9 g/kg of the product
Chlorophyll-a	6.1 g/kg of the product	7.6 g/kg of the product

The blue-green microalgal spirulina, used in daily diets of natives in Africa and America have been found to be a rich natural source of proteins, carotenoids and other micronutrients. Experimental studies in animal models have demonstrated an inhibitory effect of spirulina Algae on oral carcinogenesis. Studies among preschool children in India have demonstrated spirulina fusiformis (SF) to be an effective source of dietary Vitamin A. We evaluated the chemopreventive activity of SF (1 g/day for 12 mos) in

reversing oral leukoplakia in pan tobacco chewers in Kerala, India. Complete regression of lesions was observed in 20 of 44 (45 percent) evaluable subject supplemented with SF. as opposed to 3 of 43 (7 percent) in the placebo arm ($p<0.001$). When stratified by type of leukoplakia, the response was more pronounced in homogeneous lesions complete regression was seen in 16 of 28 (57 per cent) subjects with homogeneous leuko plakia. 2 of 8 with erythroplakia, 2 of 4 with verrucous leuko plakia and 0 of 4 with ulcerated and nodular lesions. Within one year of dis continuing supplements 9 of 20 (45 percent) complete respondents with SF developed recurrent lesions. Supplementation with SF did not result in increased Serum concentration of retinal or B-carotene, nor was it associated with toxicity. This is the first human study evaluating the chemopreventive potential of SF. More studies in different settings and different populations are needed for further discussion. [91]

Thus spirulina is a rich source of easily digestible protein readily usable in several food, cosmetic and animal feed preparations. It is also easily produceable and technology for its production has been developed indigenously and perfected for field application. This provides an opportunity for the firms to take up mass production of spirulina. Several studies show that production of spirulina is economically viable and the real concern is with marketing. Therefore, it is necessary to evaluate the market potential for spirulina so that suitable marketing strategy may be formulated and practiced to exploit the potential. The study is one such attempt in Tamil Nadu.

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[91] Mathew Babu *et al.*, Evaluation of Chemoprevention of oral cancer with Spirulina fusiformis, Nutr. Cancer, 24(1) : 197-202, 1995.

DESIGN OF THE STUDY

CHAPTER III

DESIGN OF THE STUDY

This chapter presents the design of the study with details on sampling design, method of data collection, tools of analysis and method for estimating the potential .

Selection of study area

In the pilot survey, it was found that the major users of the spirulina powder were the pharmaceutical firms. The animal feed firms have the potential to use the spirulina as a feed source for poultry, cattle, fish and shrimp farming. So the study was concentrated among the prime users i.e. the pharmaceutical industry. The Tamil Nadu state was purposively selected for the study as majority of firms using this powder for drug manufacturing is concentrated.

Sampling design

The total number of pharmaceutical firms in Tamil Nadu state was collected from Tamil Nadu Pharmaceutical and Drug Manufacturers Association, Chennai. There are about 179 pharmaceutical firms throughout Tamil Nadu and among them 71 per cent i.e. 139 firms are located in and around Chennai alone. So it was decided to concentrate at Chennai for the study. Since the time was very short, it was decided to select 30 firms from among the 139 firms in random manner from the address collected.

The sample size constituted 17.5 per cent of the total number of units located in Tamil Nadu and 21.6 per cent of the units located at Chennai alone.

The similar approach was adopted for animal feed firms located at Namakkal. The sample size constituted 19.2 per cent of the total firms located at Namakkal.

For the study of producers of spirulina powder, all of them were contacted i.e. three producers including one at Mysore as he was also a supplier to Chennai based pharmaceutical firms. The name of the company, location are given below:

1. Ballarpur Industries Limited, Nanjangude, Mysore.
2. New Ambadi Estates Private Limited, Sevariarpuram Pudukottai Dt.
3. Parackal Farms Limited, Arcot, Madurantakam.

Method of collection of data

A pilot survey was conducted initially so as to design the questionnaire in an exhaustive manner to collect the data regarding the study.

There were three different sets of questionnaires separately for producers of spirulina, the prime users pharmaceutical firms and for the animal feed firms. The interview schedule method was used to collect the information regarding the study. For effective data collection and being a new product, a brief introduction about the objective of the study was explained so as to get full coopération from the respondents.

Information related to production, cost of production, fixed investment, fixed cost, variable cost, marketing promotion methods, current market demand, export details, problems associated with marketing etc., were collected and these information constituted the primary data.

The secondary data for this study was collected from the following Government/ Non-Govt. institution.

1. Central Food Technological Research Institute, Mysore
2. Directorate of Agrioultural Statistics, Chennai.
3. Tamil Nadu Pharmaceutical and Drug Manufacturer's association, Chennai.
4. Namakkal Animal Feed Manufacturer's Association, Namakkal.

Period of study

The survey was conducted from November '96 to December '96.

Tools of Analysis

Average and percentage analysis were used to study about the general characteristics of user industry and producer industry. It is also used for analysing the average consumption, capacity utilization and awareness of spirulina.

Garette Ranking technique

Garette Ranking technique was used to rank different factors which attributed for the consumption and marketing of spirulina.[1] It was also used to rank the problem associated with production of spirulina, to rank the promotional method of spirulina made drug by the pharmaceutical firms. The order of merit assigned by the respondents were converted into ranks by using the formula,

$$\text{Percent position} = \frac{100 \times (Rij-0.5)}{Nj}$$

where,

Rij = Rank given ith factor by jth individual

Nj = Number of factors ranked by jth individual.

By referring to Garette's table, the percent position estimated were converted into scores and then for each factor the scores of various respondents were added and mean value was calculated. The mean were arranged in a descending order. The problem having the highest mean value was considered to be the most important.

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[1] Hendry E.Garett and R.S.Woodworth , **Statistics in Psychology and Education** , (Bombay: Vakils, Fetter and Simons Private Limited ,1969), p.239.

Compound growth rate

By taking time (in months) as an independent variable and the requirement of spirulina, monthwise for the pharmaceutical companies as the dependent variable, the compound growth rate was worked out. The function was fitted as,

$$y = AB^t$$

where,

Y = Requirement of spirulina powder, monthwise.

t = time in months

A = Intercept term

B = Parameter to be estimated

By taking log on both sides, the following form was arrived at:

log Y = log A + log B

Let, Log A = a, Log Y = y, Log B = b.

So Y = a+bt

This linear function is fitted by using principle of ordinary least squares. Then the compound growth rate is given by,

CGR = (antilog b-1) x 100

CGR was substituted in following formula to arrive at the projected requirement.

$$Qa = Qo \left[1 + \frac{r}{100} \right]^N$$

where,

Qa = Projected requirement for the month 'a'
Qo = requirement in the base year
r = CGR
N = Number of months.

DESCRIPTION OF THE STUDY AREA

CHAPTER IV

DESCRIPTION OF THE STUDY AREA

For planning any programme or project in a particular area, it is important to have a clear idea and knowledge of that particular region in terms of agro-climatic features, socio-economic conditions etc. The economic-demographic and socio-environmental factors of the study area has some direct or indirect influence on the marketing activities. In this chapter a brief description of the study area, viz., of Tamil Nadu is presented so that, this would form a background for the research work.

Tamil Nadu

Tamil Nadu is situated at the South eastern extremity of Indian peninsular and lies between 8°5' and 13°35' Northern latitude and 76°15' and 80°20' Eastern longitude. It is bounded on the North by Karnataka and Andhra Pradesh, on the east by Bay of Bengal, on the South by Indian ocean and on the West by Kerala state (shown in Fig.2). The total area of the state is 130069 Sq.km with a coastal line of 922 km and a land boundary of 1200 km. State capital is Chennai with 29 districts, 170 taluks, 1099 blocks and 17047 villages.

Soils

Some major type of soils found in Tamil Nadu are,

i) Black soil

ii) Alluvial soil

iii) Laterite soil and

iv) Red soil

The Black soil is found in all districts except Nilgiris. Red soil is found in South Arcot Vallalar and composite Ramanathapuram districts. The alluvial soil can be broadly classified into saline coastal alluvial and river alluvial. Saline coastal alluvial soils occur

only in the coast as a narrow belt in the districts of Chengai MGR, South Arcot Vallalar, Tanjore, Ramanathapuram, VOC, Tirunelveli and Kanyakumari. The Laterite soils are found in Nilgiris and other hilly area of high rainfall.

Climate and Rainfall

In Tamil Nadu, climate is basically tropical more equitable than that of North India due to proximity of the sea. The normal annual rainfall in the State ranges from 720-1920 mm. The districts can be classified according to the range of rainfall as shown in Table : 9

Table : 9.- Classification of districts according to rainfall range

Sl.No.	Range of rainfall(in mm)	Districts
i.	< 800	Coimbatore, Periar
ii.	800-1000	Pudukottai, Tirunelveli, Ramanathapuram, Pasumpon Thevar Thirumanagar, Kamarajar Dindigul Anna, VOC, Madurai, Salem, Dharmapuri, North Arcot Ambedkar and Trichy
iii.	1000-1200	South Arcot Vallalar, Tanjore
iv.	1200-1400	Chennai, Chengai MGR
v.	1400-1800	Kanyakumari
vi.	1800 and above	The Nilgiris

Source : Directorate of Agriculture, Chennai-5, 1995.

The occurance of drought is frequent. The timely receipt of rain has a decided influence on the land use and cropping pattern of the State. The Western Ghats acting as a barrier deprive the state of the full receipt of South West Monsoon winds. However, Southwest monsoon has a precipitation of about a third of normal rainfall received in Tamil Nadu which helps in taking up the rainfall cultivation. The State depends mainly on the North East monsoon rains which are brought by the troughs of low pressure establishing in South Bay of Bengal between October-December. The normal rainfall during major seasons viz., South West Monsoon, North East Monsoon, Winter and Summer are shown in Table : 10.

Table : 10.- Annual Rainfall state average : Tamil Nadu (in mm)

Calendar year	Winter (Jan & Feb)	Summer (March to May)	South West Monsoon (June to Sept)	North East Monsoon (Oct to Dec)	Annual (Jan to Dec)
1961	86.8	87.8	371.0	309.8	855.4
1971	28.5	151.4	323.3	488.5	991.7
1981	10.5	125.4	406.1	449.0	991.0
1991	31.1	72.6	331.8	484.9	920.4
1995	41.8	136.1	308.4	436.8	923.1

Source : Agrostat, 1995,p.16
Directorate of Agriculture, Chennai-5.

State average number of rainy days per year is 50 days and the highest is 106 days in Nilgiris and the lowest is 46 days in Ramanathapuram.

Temperature

The day temperature in plains generally range from 29°C (Jan) to 38°C (May) and night temperature from 19°C to 27°C. In hilly region like Nilgiris and Kodaikkanal the day temperature varies from 19°C to 24°C and night temperature from 8°C to 16°C.

Population

As per the 1991 census the total population was 56 million, of which males were marginally larger in number as shown by the sex ratio of 1020 males for ever 1000 females. The details of population for India and Tamil Nadu are presented in Table : 11. About 30.38 million people were literate (62.66 percent).

Table : 11.- Growth of human population - India and Tamil Nadu (1951 to 1991)

Sl. No	Year	Million persons	
		India	Tamil Nadu
1.	1951	361	30 (8.34)
2.	1961	439	34 (7.67)
3.	1971	548	41 (7.52)
4.	1981	684	48 (7.07)
5.	1991	846	56 (6.06)

Source : Tamil Nadu : An Economic Appraisal, 1994-95, p.186

Note : Figures in parentheses represents per cent to the Indian population

As could be seen in the table, population of Tamil Nadu had nearly doubled (1.87 times), while that of India has increased by 2.34 times. The steady growth in population increases demand for food and nutrition and spirulina has a role to help the latter.

Even though there was an up trend in the size of human population, the annual growth rate showed significant variation in Tamil Nadu between the decades. Details are presented in Table : 12.

Table : 12.- Annual Growth rate of human population: India and Tamil Nadu over the decades (%)

Sl.No.	Year between	Annual growth rate	
		India	Tamil Nadu
1.	1951 and 1961	2.0	1.1
2.	1961 and 1971	2.2	2.0
3.	1971 and 1981	2.2	1.6
4.	1981 and 1991	2.1	1.4
5.	1951 and 1991	2.2	1.6

Source: Tamil Nadu : An Economic Appraisal, 1994-95, p.186.

As could be seen in the table the growth rate of human population of India was around 2.2 per cent per annum for the four decades ending 1991, it showed a marked variation for Tamil Nadu. From 1.1 per cent in 1950's it rose to two per cent in the sixties and then declined to 1.6 per cent and further to 1.4 per cent in the seventies and eighties respectively. For the period from 1951 to 1991 (period of planned development) the average growth rate of human population of Tamil Nadu was 1.6 per cent as against 2.2 per cent for all India. This relatively smaller growth rate of Tamil Nadu could be explained by the changes in the vital statistics. Details are presented in Table : 13.

Table : 13.- Birth rate, Death rate and Infant mortality in Tamil Nadu : 1988-1993

(No. per thousand)

Sl.No.	Year	Birth Rate	Death Rate	Infant Mortality rate
1.	1988	22.7	9.3	74
2.	1989	23.1	8.7	68
3.	1990	21.6	8.5	59
4.	1991	20.8	8.8	57
5.	1992	20.7	8.4	58
6.	1993	19.2	8.0	56

Source: Tamil Nadu : An Economic Appraisal, 1994-95, p.194.

The birth rate for human population of Tamil Nadu was 22.7 per thousand persons in 1988 and the death rate was 9.3 persons per thousand. By 1993, they declined to 19.2 per thousand and eight per thousand respectively, contributing to the lower growth rate in Tamil Nadu as compared to that in India. However, the rate of infant mortality was still high at 56 per thousand births though the reduction in it over the years was not small. From 74 per thousand births it had come down to 56 per thousand births in 1993. It should be further reduced and one way was to remove the nutritional deficiency- especially protein and vitamin deficiencies in children and mother. Spirulina could be a good protein supplement.

However, mere production and supply of protein would not be sufficient, because majority of the population would not be able to avail the supply for lack of knowledge of nutritional needs or purchasing power. A knowledge of extent of poverty would show this. Details are presented in Table : 14.

Population below poverty line for 1977-78 and 1987-88 were compared and presented in Table : 14.

Table : 14.- Population below poverty line in Tamil Nadu

(in millions)

Sl.No.	Year	Population		
		Rural	Urban	Total
1.	1977-78	17(56.3)	6.7(45.3)	23.7(52.8)
2.	1987-88	13.8(39.5)	3.9(20.5)	17.7(32.8)

Source : CMIT, Basic Statistics : States, September 1994.

Note : Figures in parentheses represents per cent to the total.

Consequent to the definition of poverty line in the mid sixties, several estimates of population below poverty line were available. Estimates for 1977-78 and 1992-93 are compared in the above table. Nearly 23.7 million persons were below poverty line in 1977-78. After nearly two decades of development planning the number of persons below poverty line had not declined much, because population had grown and more number had been added to the poor. By 1987-88, 17.7 million persons were below poverty line of which.13.8 million persons or 39.5 per cent were in rural areas and 3.97 million or 20.5 per cent in urban areas. Thus rural poverty was very large and for them nutritional security had to come by the supply of essential food at affordable prices. Therefore food subsidy and public distribution system had to play a significant role. Production and supply of spirulina in a cost effective way might be one of several possible solutions.

Price situation

The concern for the low priced supply of protein food in general and of spirulina in particular could be seen in the significant rise in price level. Inflation would eat into the real purchasing power of the poor.

The general price situation in the State is measured by the Whole sale Price Index (WPI) with the base year 1970-71. The WPI had warmed up during 1994-95 and stood at 800.5 compared to previous year's 728.20. The index moved up by 9.9 per cent in 1994-95 as against 3.2 per cent for the previous year.[1] Thus, with high rate of inflation there was the problem of escalation of malnutrition and under nutrition among poor in Tamil Nadu.

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[1]Tamil Nadu : An Economic Appraisal, 1994-95,p.135.

Per capita income

The percapita income at constant price and at current price from the year 1990-91 to 1994-95 are shown in Table : 15. In the year 1994-95 the percapita income was Rs.2504 at constant price and Rs.8283 at current prices.

Table : 15.- Percapita Income for Tamil Nadu State (Rs)

Sl.No.	Year	Percapita Income	
		at constant price (1980-81)	at current price
1.	1990-91	2275	5076
2.	1991-92	2309	5878
3.	1992-93	2355(RE)	6663(RE)
4.	1993-94	2410(QE)	7352(QE)
5.	1994-95	2504(AE)	8283(AE)

Source : Tamil Nadu : An Economic Appraisal, 1994-95,p.5

Note : RE - Revised Estimate QE - Quick Estimate AE - Advanced Estimate

At 1994-95 prices the average per capita income for the state as a whole was Rs.8283. The poverty line income at 1994-95 prices was Rs. 3047.[2] Therefore on the average income percapita was substantially larger than that of poverty line. However. this conclusion was deceptive, because there was a very wide variation in income distribution and the average was not representative of the real situation. Estimates of poverty in Tamil Nadu was 32.8 per cent in 1987-88 had increased to 39.1 per cent

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[2]Special correspondent, " Plan panel releases poverty estimates," "**The Hindu**", January 6, 1996,p.13.

in 1994-95. To them malnutrition was a rule rather than exception. This nutritional deficiency could easily be seen in the estimates of protein contents in the diet.

Per capita consumption of protein

The percapita availability of pulse in Tamil Nadu was 69 g in 1961 and it had come down to about 39 g in 1996.[3] The ICMR recommends a minimum protein consumption of 55 g per day[4]. The consumption of pulses, vegetables, fruits and animal product contribute to the protein in the diet. This consumption needs to be stepped up to bridge the difference between actual and recommended levels of protein consumption.

However, these items of food are relatively costly and the poor consume very little of them. Their production should be substantially increased to reduce their prices, but low prices would be a disincentive for production, especially when land and irrigation water are becoming scarce and consequently, very costly.

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[3].Indian Economic Survey, 1996-97, p.143.

[4].K.S. Singh, **Animal Nutrition**, (New Delhi : Kalyani Publishers,1997), p.268.

Crop pattern

The cropping pattern of Tamil Nadu in 1994-95 is shown Table : 16.

Table : 16.- Area under crops : By Major Crop Groups

(in lakh hectares)

	Group	1993-94	Per cent	
I	Food crops			
	a.Rice	23.06	32.22	
	b.Other cereals	10.31	14.4	
	c.Pulses	6.90	9.64	
	Food grains (a+b+c)	40.27	56.26	
	d.Condiments and spices	1.80	2.52	
	e.Sugar crops	2.68	3.74	
	f.Fruits and vegetables	4.26	5.95	
	g.Other misc. food crops	--	--	
	Total (I)	49.01		68.47
II	Non food crops			
	a.Fibres	2.31	3.23	
	b.Oilseeds	15.86	22.16	
	c.Dyes	0.07	0.10	
	d.Drugs and Narcotics	1.10	1.54	
	e.Fodder	1.80	2.51	
	f.Green manures	0.04	0.05	
	g.Other misc. non foodcrops	1.39	1.94	
	Total (II)	22.57		31.53
	Total Cropped Area (I+II)	71.58		100.00

Source :Tamil Nadu: An Economic Appraisal, 1994-95, p.S-57.

The staple food in the state crops grown are paddy, maize, jowar, bajra, pulses and millets. Important commercial crops are sugarcane, oilseeds, cashewnuts, cotton, tobacco, coffee, tea, rubber and pepper.

As could be seen in the table the food crops dominated the crop pattern. Among the food crops rice and other cereals accounted for largest percentage of gross cropped area. Of particular importance for this study was the small area under fruits and vegetables. So the people of the state depended upon pulses for supply of protein.

Agriculture:

The land is fertile plain watered by rivers flowing East from the Western Ghats. particularly the Cauvery and the Tambaraparani. Of the total land area (13 m. ha) 6.509.349 ha were cropped even while the area classified as cultivable waste was as large as 298.659 ha. Land utilization in Tamil Nadu is given in Table : 17.

Table : 17.- Area under crops in Tamil Nadu (in lakh ha)

Sl.No.	Year	Area cropped		
		Net	More than once	Gross
1.	1950-51	51.5	7.40	58.90
2.	1960-61	59.9	13.30	73.20
3.	1970-71	61.7	12.20	73.90
4.	1980-81	53.6	11.10	64.70
5.	1990-91	55.8	10.50	66.30
6.	1993-94	59.0	12.58	71.58
7.	1994-95	57.9	12.36	70.26

Source : Agrostat,1995. p.92. Directorate of Agriculture, Chennai.5.

Net areacropped is showing an increasing trend initially and then decreased and finally increased. Area sown more than once had increased and stabilized around 12.36 l.ha. The gross cropped area had increased from 58.90 l.ha in 1950-51 to 70.26 l.ha in 1994-95.

When net area sown had not shown much increase the substantial increase in gross cropped area indicated very intensive cropping practice.

Production of pulses in Tamil Nadu is shown in Table : 18.

Table : 18.- Production of pulses in Tamil Nadu (in L MT)

Sl.No.	Year	Production
1.	1970-71	1.334
2.	1975-76	1.274
3.	1980-81	1.756
4.	1985-86	2.752
5.	1990-91	3.590
6.	1991-92	3.482
7.	1992-93	3.312
8.	1993-94	3.427
9.	1994-95*	2.764
10.	1995-96*	3.591

Source : Indian Economic Survey, 1996-97, p-S.21

Note : * Provisional

The pulse crop is the major source of protein for the dominant vegetarian population of the state. The pulse production has shown a steady increase, but slow and it is inadequate to meet the requirement of the population of the state even at the current low level of consumption percapita. Flow from other states bridge the gap between current production and current consumption of pulse in Tamil Nadu Production has just doubled in 1995-96 compared to the production in 1970-71. This is attributed mainly because of growing pulse crop in rainfed and as a mixed crop, reduction in the area sown, and less research and development activities in pulses. Research and development

activities in pulses would not be able to match the requirement fully. Therefore, there is need to find other protein supplements and spirulina can be one such alternative.

Live stock

Part of the protein deficiency is made good by the consumption of animal products. The state has a large wealth of live stock.

The total animal population as per Livestock Census (1989) categorywise is given in Table : 19.

Table : 19.- Livestock population in Tamil Nadu (Numbers)

Sl.No.	Category	Population (in numbers)
1.	Cattle	9353141
2.	Buffaloes	3128256
3.	Sheep	5880788
4.	Goat	5919713
5.	Fowls	21037244

Source : 14th Livestock and Poultry census-1989, Commissioner of Statistics. Chennai-6, p.S-92,93

However, the live stocks were low producers and their supply of animal protein was also inadequate to mitigate protein deficiency in the state. Their production and protein content in them could be improved by balanced feeding of the animals.

The total feed production by compound feed industry for the year upto 1987 is given in table 20.

Table :20.- Feed production by Compound Feed Industry ('000 tons)

Sl.No.	Year	Cattle and other feeds	Poultry	Total
1.	1964	25.0	14.4	39.4
2.	1965	53.3(113)	25.4(72)	78.7(100)
3.	1970	125.4(27)	84.3(46)	209.7(33)
4.	1975	275.3(24)	143.9(14)	419.7(20)
5.	1980	549.9(20)	350.2(29)	900.1(23)
6.	1985	867.3(11)	502.8(9)	1370.1(10)
7.	1987	1229.0(21)	654.3(15)	1883.3(19)

Source : C.V.Reddy, "Feed Industry-2000 A.D.", **Poultry guide** : 26(3), 41, March 1989.

As could be seen in the table, there was an uptrend in animal feed production, it had to be sustained. One way for it, was to make the feed more productive, by reinforcing their protein content. Spirulina had the potential to meet this need, if it were reasonably priced.

Fishery

Another source of protein for human diet is fish. In 1991-92, out of total 384,000 tonnes of fish, 302,000 tonnes from marine source and 82,000 tonnes was from inland source. The inland fish production details are presented in Table : 21.

Table : 21.- Inland fish production : By sources (tonnes)

Sl.No.	Source	90-91	91-92	92-93	93-94	94-95
1.	Major Reservoir	2400	2650	3100	3400	1465
2.	Minor Irrigation Tanks (Both perennial & long seasonal)	25000	25650	32100	34950	38460
3.	Seasonal tanks and ponds	3500	35800	39400	42950	43000
4.	Estuaries and Backwater	3000	3100	3650	4000	4500
5.	Fish farms Development Agency	2800	2900	3400	3700	3575
6.	Rivers, stream, canals and other water source	2000	12050	14600	15900	15000
7.	Misc. (Rice fields, swamps etc.)	1800	1850	2150	2300	2000
	Total	82000	84000	98400	107200	108000

Source : Tamil Nadu : An Economic Appraisal, 1994-95, p.S-98.

As shown in table this uptrend should be sustained.

Industry

The number of working factories in Tamil Nadu was 14,202 in 1990, employing 840,086 workers. In 1991-92, there were 138,404 small industries employing 1,494,763 persons. The biggest central sector project was Salem Steel Plant. Other important industries were cotton textile, cement, sugar, textile machinery, power-driven pumps, bicycles, elctrical machinery, tractors, motor cars, rubber tyres and tubes, bricks and tiles and silk. Spirulina is emerging as an important industry in the state.

Thus production and sale of spirulina as a source of protein in pharmaceutical preparations and animal feed has a good potential. It was also a prospective protein supplement directly in human diet through bread, *roti*, beverages and processed food items; but there was no effort even as late as 1995. The exploitation of this vast potential depends however, on the economics of production (including the marketing cost) of spirulina. It is the focus of this study.

RESULTS AND DISCUSSION

CHAPTER V

RESULTS AND DISCUSSION

The information secured from different sources and data collected from sample respondents viz., producers of spirulina, pharmaceutical units and animal feed units were analysed with reference to the objectives of the study. The results are presented and discussed in this chapter, divided into two sections. First section presents a discussion of economics of production of spirulina powder. In the second section, market potential for spirulina powder is discussed.

SECTION-I ECONOMICS OF PRODUCTION

In this part of the discussion, various issues relating to spirulina production, distribution of production units, capacity utilisation, the economics of production, and problems in production are discussed.

PRODUCTION

The spirulina is grown in natural lakes in some parts of world . The map showing the occurance of such natural lakes is shown in Figure:3. The major spirulina species used for commercial production are, *Spirulina fusiformis*, *Spirulina maxima* and *Spirulina platensis*. .

The source of inoculam and technology can be got from central food Technological Research Institute (CFTRI), Mysore and Indian Agricultural Research Institute (IARI), New Delhi. The spirulina research centers in South India are listed in the exhibit below:

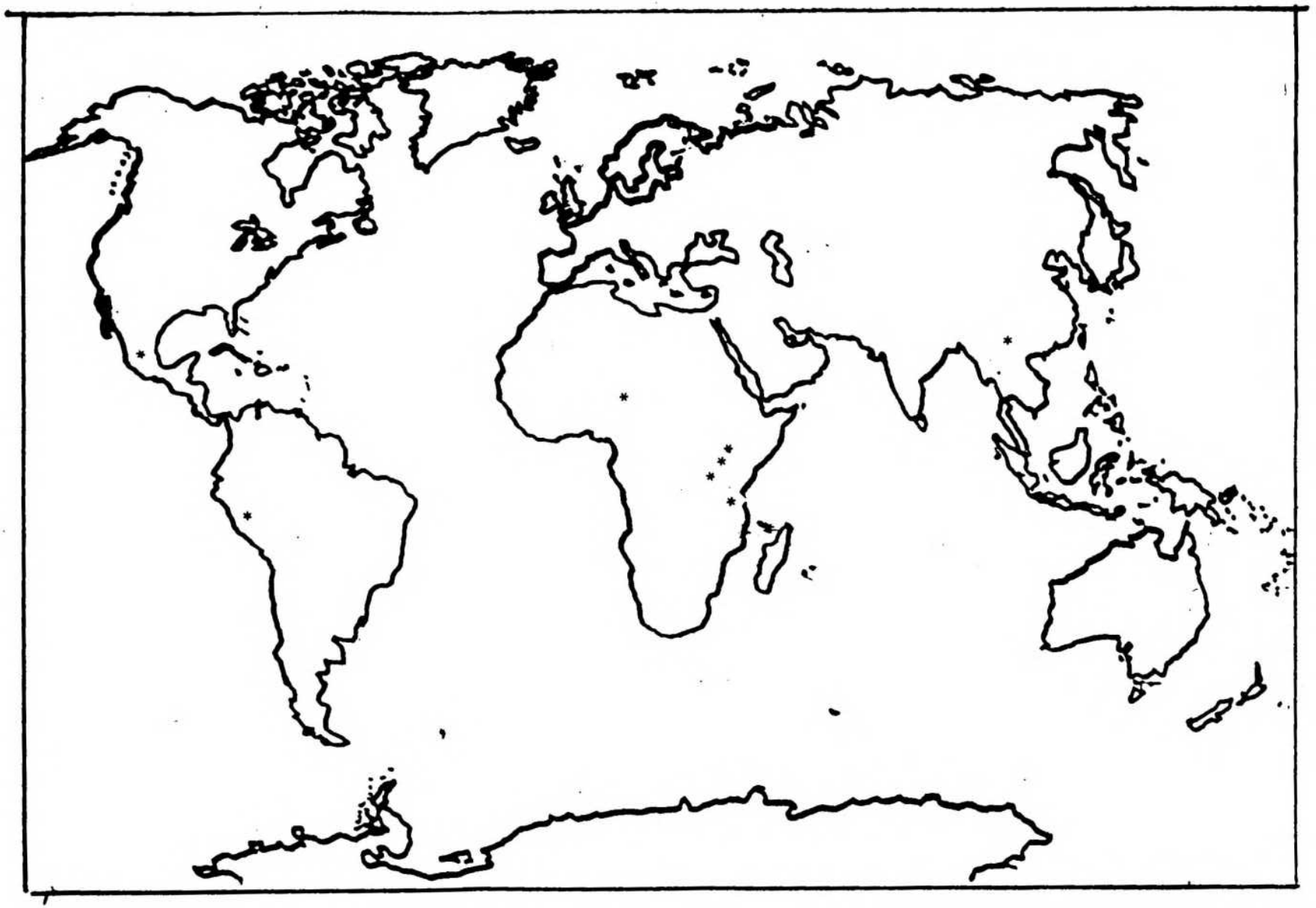

Fig.3 Map showing Natural spirulina growing lakes in the world

Figure: 4-Spirulina Research Centers in South India*

Sl.No.	Institute	Region and climate
1.	Central Food Technological Research Institute, Mysore, Karnataka-570 013. India.	South India (Interior Karnataka) Mild climate medium rainfall
2.	Murugappa chettiar Research centre (MCRC), Tharamani Chennai-600 042. India.	South India (Tamil Nadu coastal region) hot, mild cold, humid heat, heat medium rainfall.

* Based on available information.

It is enough to get the mother culture once; it can be maintained in the glass carboys for further cultivation.

Spirulina Commercial Plants

The commercial units producing spirulina on commercial scale in South India are listed in table below:

Table: 22.- Spirulina commercial units in South India

Location	Numbers
Karnataka State (Mysore and Banglore)	2
Tamilnadu State (Pudukottai Sevariarpuram and Madurantakam Arcot)	2
Total	4

There are two units each in Karnataka and Tamil Nadu. The agro-climatic condition prevailing in the region is highly suited to spirulina production

Capacity Utilisation

The major producers of spirulina in South India, their installed capacity and capacity utilization are shown in Table : 23.

Table: 23.-Spirulina Production in South India (TPA)

Sl.No.	Company, location	Installed Capacity	Capacity utilization	Percentage share (per cent)
1.	Ballarpur Industries Limited, Nanjangude, Mysore.	120	72 (60)	37
2.	New Ambadi Estates Private Limited, Sevariarpuram puram, Pudukottai.	150	120 (80)	61
3.	Parackal Farms Private Limited Arcot, Madurantakam.	10	2 (20)	2
4.	Cyanotech Bioproducts Limited.	8	5	

Note : Figures in parentheses represents the percentage to the installed capacity (TPA) of the plant.

TPA- Tonnes per annum

Of four producers, the Cyanotech Bioproducts limited is extracting C-phycocyanin from spirulina powder. Since this is not coming under raw spirulina powder production, this is not covered by this study. The total production of spirulina from other units is 194 TPA in 1996. It works out 67 per cent utilisation of capacity of

290 TPA. Among the three producers the market share of New Ambadi Estates Private Limited is 61 per cent, followed by Ballarpur Industries Limited 37 per cent and the Parackal Farms Private Limited two per cent. The price of spirulina offered by New Ambadi Estates Limited is Rs. 700 per kg which Rs. 50 per kg less than those of Ballarpur Industries Limited and Parackal Farms Pvt. Limited. Being a major share holder, the New Ambadi Estates fixed a price which is lower than the other two firms. This may lead to price reduction by the other two firms due to competition among them.

Growth in Production

The commercial Production of spirulina powder has its beginning only recently in 1993, but it shows a steady uptrend as shown in Table: 24 and Figure. 5. .

Table: 24.- Production trend in spirulina powder (TPA)

Sl.No.	Year	Production
1	1993	104
2	1994	150
3	1995	182
4	1996	194

As one could see from the table, total production had nearly doubled in first four years; revealing ready market availability. The main factor contributed for this growth is the expansion of export market and also a steady increase in the domestic market(pharmaceutical firms).

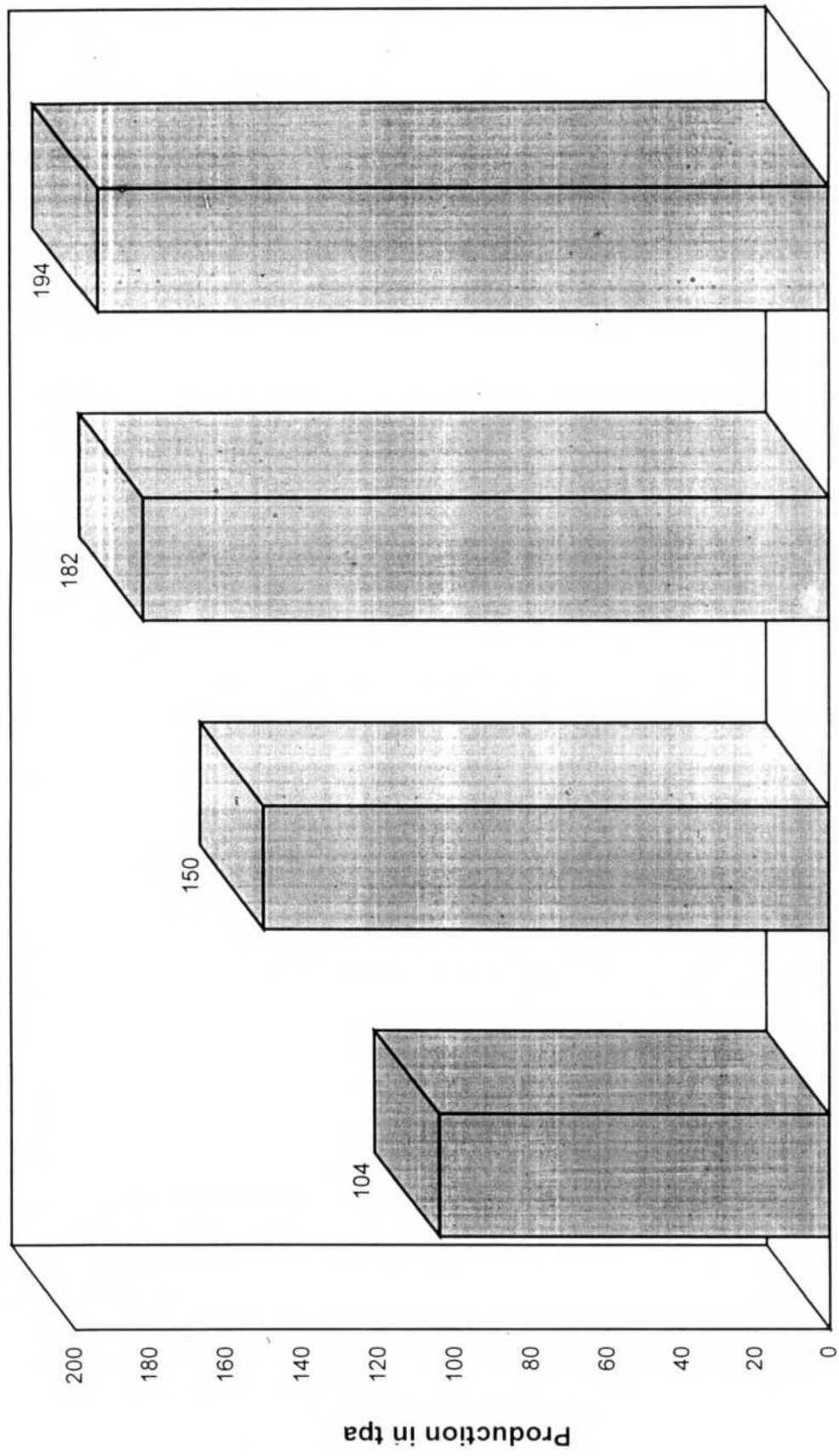

Fig. 5. Production trend in spirulina powder

Factors influencing production of spirulina

The answer to the question was found from the opinion survey of producers and users. As reported by them there are atleast five factors that influenced the production of spirulina . They are listed below along with the Garette rankings based on the scores assigned by the respondents.

Table: 25.-Factors influencing the production of spirulina

Sl.No	Factor	Mean Score	Rank
1.	Price of the product	65.00	2
2.	Climatic conditions	56.67	5
3.	Final product quality	65.33	1
4.	Promotional Activities	58.33	4
5.	Quality of water	60.67	3

The above factors are discussed below in some details.

(i) Final product quality

The quality of the final product received the first rank, because spirulina was not consumed directly, rather it reached the people through pharmaceutical preparations, which would find market on the recommendation of physicians, who would recommend products of high quality.

Spirulina finds market as a source of protein, mineral and vitamin contained in it. As the immediate users of spirulina are commercial firms producing pharmaceuticals and animal feed , they have elaborate facilities to evaluate the quality of spirulina powder in terms of its content. Therefore the quality of spirulina powder is a major determinant of its sales. Therefore, the final product should be above the minimum standards prescribed

by the Bureau of Indian standards, for spirulina food grade. The quality standard for feed grade are little lower than those for food grade specification. The food grade specification is given in Table: 26. The product may be rejected if contaminated by presence of insects, micro organisms, fermentation or by poor nutrient content. This is especially important for exports, where the supply might get rejected due to poor nutrient content or due to the presence of even a single insect in a whole lot.

Table: 26- Quality standards for alga spirulina food grade specification

Characteristic	Requirements
Maximum allowed moisture	9.0 %
Maximum Ash content	9.0 "
Maximum insoluble ash	0.5 "
Minimum Protein	5.5 "
Maximum quantity (in mg g^{-1})	
Lead	2.5
Arsenic	1.1
Cadmium	1.0
Mercury	0.1
Maximum *Coliform* bacterial count g^{-1}	Absent (in 0.1g)
Salmonella sp	Absent (in 0.1g)
Shigella sp	Absent (in 0.1g)
E.coli	Absent (in 0.1g)

Source : Bureau of Indian Standards, (Document IS:12895:1990)

Note : % Percentage on dry matter basis

(ii) Price of the product

The price is comparatively high for spirulina protein when compared with other sources of protein. This is due to the margin that is kept by the producers to earn profit. Considering the nutritional content if lower price is offered it would boost sales of spirulina powder. A more competitive situation may bring the prices lower than that at present. This aspect would be discussed in further details later.

(iii). Quality of water used for production

Being an input for the spirulina production water has a direct relationship with the production of spirulina. The quality of water must be above the neutral pH i.e. pH range of 7-7.5 as the nutrient addition may further increase the pH to a range of 8.5-9.5 which is the optimum condition for the growth of spirulina.

Of the three producers , one is using river water (Ballarpur Industries Ltd.), another is using Ground water (New Ambadi Estates Ltd.) and the third one is using brackish water.

The water should not contain heavy metals as this will be absorbed by the algae and the product would be poisonous.

(iv). Promotional activities

The promotional activities if effective, would significantly increase the sales. There are a few specific strategies for sales promotion and details would be discussed latter.

(v). Climatic condition

The climatic condition has some effect on production. Heavy rains or high day temperature affects the production. A conducive climate of cool, sunny day of mild weather is preferred.

In the discussion above promotional activities were shown to be a factor influencing production of spirulina. The promotional activities currently in use were identified and evaluated for their relative importance with the help of Garette ranking technique. Details are presented in Table : 27.

Table 27. -Major promotional methods

Sl.No.	Method	Mean score	Rank
1.	Direct contact	60.83	1
2.	Audio visual methods	58.90	2
3.	Exhibition, Trade Fair participation	57.13	3
4.	Market visits	54.66	4
5.	Advertisement in mass media	50.00	5

As could be seen in the table, spirulina producers used five different promotional strategies for spirulina; usually in combinations of them. The producers were asked to rank them in the order of importance. The scores assigned by them were analysed and the strategies were ranked in the descending order of effectiveness based on the mean score values. The direct personal contact emerged to be the most effective method in the opinion of the producers. Necessarily it would be very costly too. Next in rank was the audio visual method - films and slide shows. Closely ranked with it are exhibition, trade fair and market visits-all bringing the prospective users very close to the information and visual observation of the product for its quality. Advertisement in mass media ranked last, because it might inform and promote awareness but buyers would wish to gain additional information on quality of the product before convinced to buy it. Thus the

ranking was logically consistent with *a priori* expectations. Producing firms had to choose a combination of them, to manage their budgets for a given level of effectiveness.

Economics of production

The details on economic of production viz., the cost of production, fixed cost, variable cost, sale price, the gross profit for the three firms were compared and presented in Table : 28.

Table: 28.-Comparative cost of production for three firms.

Sl. No	Details	Unit	Firm1	Firm2	Firm3
1.	Installed capacity	TPA	150	120	10
2.	Production	TPA	120	72	2
3.	Capacity utilisation	per cent	80	60	20
4.	Fixed investment	Rs.crores	7.5	6.00	0.5
5.	Fixed cost	Rs.(lakh)	68.00	57.10	12.62
6.	Variable cost	Rupees lakh	315.00	210.50	239.6
7.	Total cost	Rupees lakh	383.00	267.60	356.7
8.	Cost of production	Rs./kg	319.17	371.67	359.69
9.	Price	Rs./kg	700	750	750
10.	Total revenue	Rs.crores/ year	8.40	6.40	0.428
11.	Gross profit	Rs.crores/ year	4.57	2.73	0.078

As could be seen in the table above, the installed capacity of the firms widely differed from 10 tpa to 150 tpa providing an opportunity to know the economics of size of production if any. It should also be noticed that greater was the capacity utilisation, the larger the capacity to produce. Capacity utilization was as low as 20 per cent with

installed capacity of 10 tpa, and 80 per cent with capacity of 150 tpa. This was a definite effect of size of capacity of plant size.

The value of fixed investments, fixed cost, variable cost increased with the increased level of production. Therefore, total cost increased as the size of production increased. The size effect could be studied more meaningfully with the help of cost of production per kg. It was Rs.334.54 per kg for a production level of 120 tpa, and rose to Rs. 349.60 per kg for 72 tpa and further to Rs.376.20 per kg for 2 tpa. Thus there was size effect no doubt, but the magnitude was not large. For an increase in production level from 2 tpa to 120 tpa, the unit cost declined from Rs.376.20 per kg just to Rs. 334.54 per kg. the market price for spirulina was the same (Rs.750 per kg) for firms 2 and 3 and marginally smaller at Rs.700 per kg for firm 1. Total revenue and gross profit varied correspondingly. One inference that could be drawn from the analysis was that even small scale production (at 10 tpa) was economically viable.

Project cost

The project cost for the 10 TPA capacity is given in Table :29.

As could be seen in Table 29, the establishment of a spirulina producing unit of capacity of 10 tpa, would require an initial investment Rs.45.95 lakhs in land, buildings, equipment and other infrastructural facilities. Among them the cost of land and buildings would cost Rs.24 lakhs and account for the major share of 52.23 per cent of total investment. This investment would be earned back over a period of time. Therefore, only the value of depreciation of these fixed productive assets would enter the annual income-expenditure statement. The land was expected to be non-depreciating or appreciating because once it was committed for the particular purpose, it would lose its mobility to other uses, except in the long run. Buildings and equipments were assumed to depreciate at the rates of five per cent and 10 per cent of their initial cost annually. The total

Table :29.- Cost of a Project to Produce Spirulina

(For 10 tonnes per annum capacity)

Group	Sl.No	Detail	Amount (Rs. lakhs)	Subtotal (Rs. lakhs)
A	1.	Land cost (1 hectare)	2.50	2.50
B		Civil works		(5.50)
	1.	Cultivation ponds (4000 Sq.m)	13.50	
	2.	Process buildings (150 Sq.m)	4.00	
	3.	Office cum lab (120 Sq.m)	2.75	
	4.	Other civil works	1.75	
				21.50
C		Equipments		(46.79)
	1.	For cultivation (paddle wheels and motors)	2.75	
	2.	For Harvesting (Vibrator sieve gravity filter)	1.75	
	3.	Drier Tray (Cross - flow type)	2.25	
	4.	Pulveriser	0.60	
	5.	Pack fill machine	0.40	
				7.75
D		Others		(16.81)
	1.	Water Treatment plant	1.25	
	2.	Effluent treatment	1.25	
	3.	Piping	1.20	
	4.	Electrical	1.50	
	5.	R&D Equipments	2.75	
	6.	Technical know - how fees	3.00	
	7.	Miscellaneous	1.25	
	8.	Preliminary & pre operative Expenses	2.00	14.20 (30.90)
		Total fixed cost (A + B+ C + D)		45.95 (100)

Note : Figures in parentheses represents to the total cost.

E. Cost of chemicals (per annum)

Sl. No	Details	Quantity (tonnes)	Unit (rate/tonne)	Amount (RsLakhs)	Sub Total (Rs Lakh)
1.	$NaHCO_3$	25.00	22500	5.625	
2.	NPK 15 : 15 : 15	7.20	10000	0.720	
3.	Super phosphate	0.90	25000	0.225	
4.	$Mg\ SO_4$	1.20	25000	0.300	
5.	Others	-	-	1.250	6.995

Cost per month = Rs. 69950

Cost per year (10 months) = Rs. 6.995 lakh

Power & utilities

F. Water

For produciton 780 lt/kg day

Additional water for washing cleaning 220liters/kg day

Charge = Rs 5.00 lakhs 5.00

G. Electricity

Total Electricity comsumption / year =30000 kwh

Cost @ 2.5/kwn = Rs.75000 0.75

		Manpower Requirement		Amount (in Rs.)	Amount (in Rs. Lakhs.)
H		Production			
	1.	Production in charge	1	10000	
	2.	Office Assistants and Accountant	1	7500	
	3.	Lab technicians	2	6000	
	4.	Accountant - store attendent	1	6000	
	5.	Operators	4	14000	
	6.	Mechanic / Electrician	1	3000	
	7.	Helpers	3	3750	
	8.	Watchman	2	2500	6.33
		Permonth		52750	
		Per annum (x12) Rs.		Rs.6.33 lakhs	
I		Administration			
	1.	Manager	1	10000	
	2.	Accountant	1	7500	
	3.	Asst./ Typist / Secretary	1	4000	2.58
		Per.Month		21500	
		Per.Annum (X 12)		258000	
J.		Marketing			
		Sales Exeative	1	10000	
		Assistant	1	4000	

Per.Month	14000	1.68
Per.Annum (X 12)	168000	
Total Variable Cost (E+F+G+H+I+J)		23.335 lakhs

Cost of project	(Rs.lakhs)
Total Fixed investment	45.950
Total Fixsd cost	12.62
Total variable cost	23.335
Total cost	35.955
Break Even point	2.40 tonnes
Cost of production (Rs./kg)	359.55

depreciation cost was worked out individually and aggregated. To it interest at the rate of 12 per cent per annum was added. The sum constituted the total fixed cost per annum and it was Rs.12.62 lakhs per year. Total cost of manpower, energy and raw materials was Rs.23.335 lakhs per year for the production of 10 tpa of spirulina. This was the total variable cost of production. Total cost was therefore total fixed cost per year plus total variable cost per year and the total cost was estimated to be Rs.35.955 lakhs per year and it would produce 10 tpa of spirulina and it worked out to Rs.359.55 per kg. At such a high cost it would not be competitive with its substitutes in the market. If the scale of production was raised, it would distribute the total fixed cost more evenly and average fixed would fall, bringing down with it average total cost also, upto a level of production beyond which the total cost might start raising due to the law of Diminishing marginal return.

Break even analysis

The optimal scale of production could be determined by the break even analysis which would be the point where marginal cost would be equal to marginal revenue from production and the average total cost would be the minimum. The break even analysis showed that the break even point, or minimum required scale of production to be 2.4 tonnes per year. Therefore, spirulina production would be most cost effective if annual production was in excess of 2.4 tonnes of spirulina powder. In the sample firm 2 produced (vide Table 27) 72 tpa of spirulina powder and received a price of Rs.750/kg. However, firm 1 produced 120 tpa and realised a price of Rs.700 only. Therefore, optimal production capacity would be between these two levels if the effect of supply depressing the market price was to be avoided. If capacity utilization was assumed to be 80 per cent the maximum observed in the sample than it would be reasonable to conclude that economic size of installed capacity was about 100 tpa and it should ensure at least 80 per

cent capacity utilization. For this level of production cost of production per kg would be around Rs.370/kg and the price would be around Rs.750/kg as in the case of firm 2.

Now the crucial question is: If firms were established with installed capacity of 100 tpa and worked with 80 per cent capacity utilization total supply from three existing firms would be 240 tpa as against 194 tpa. If more number of firms came into production each with this scale of operation, the aggregate market supply would be in excess of 240 tpa. Would the market be able to absorb this supply without any effect on price received by the firms? An attempt is made in the next section to answer this question by analysing the market potential for spirulina powder.

SECTION-II MARKET POTENTIAL FOR SPIRULINA

Of the total quantity of spirulina produced nearly 77.3 per cent is exported and only 22.7 per cent is sold to domestic market. Sale of spirulina is given in Table 30.

Table: 30.-Sale of spray dried spirulina

Sl.No.	Sales to	Quantity(tonnes)	Per cent
1.	Pharmaceutical firms	40	20.6
2.	Export firms	150	77.3
3.	Animal feed firms	4	2.1

In domestic market sales to pharmaceuticals accounted for 20.6 per cent and for animal feed firms it was 2.1 per cent only. The fact that nearly 77 per cent of production extend export market, would show that Indian made spirulina powder had comparative cost advantage in the international market, even at the present level of cost of production per unit. Definitely there was scope for further reducing unit cost of production by improvement in capacity utilization and operational efficiency to reduce variable cost per unit. Therefore, production for export had a vast in fact unlimited potential for spirulina

powder. A policy of the Government for providing logistic support by way of infrastructure, market identification and quality control would enhance the capacity to export still larger quantities.

In the domestic market pharmaceutical firms hold the market. An aggressive selling practice by the spirulina producers would easily expand domestic demand with pharmaceutical. The profit margin for the producers was sufficiently large to absorb the additional cost of market promotion for aggressive selling. At the current level of unit cost of production, spirulina powder had little scope for increasing sales to feed manufacturers, because they have cheaper alternate sources of protein supply.

Pharmaceutical Industry

Of the total of 139 pharmaceutical units in Chennai, there are seven units use the spirulina at present for preparing health drugs. Mostly tablets, but a few capsules are also produced. It is promoted by focussing various qualities of spirulina and in combination with other drugs. The spirulina owing to its physical property would very well incorporated in tablets, capsules etc...

The price of spirulina made drugs and requirement of spirulina powder by these pharmaceutical firms is given in Table 31.

Table: 31.- Price of spirulina made drugs and requirement of spirulina powder

Sl. No.	Drug	Form available (tablet-mg)	Price (Rs/tablet)	Percent of Spirulina in the composition	Requirement per month (kg)	Purchase price (Rs/kg)
1.	Nuthera	500	1.6	100	50	750
2.	Skincare	100	3.00	28.5	60	700
3.	Natoxid	500	1.30	100	750	700
4.	Recolina	750	2.00	100	1000	700
5.	Reliv	100	1.70	20	50	800
6.	Multinol	500	1.50	100	1000	750
7.	Progen	500	1.25	100	50	750

The average requirement of spirulina powder was at present three tonnes. Major purchase is by BPRL (33 per cent)and New Ambadi Estates Private Limited (33 per cent). The American Remedies using 25.3 per cent of total sales came last. The purchase price of spirulina varied between Rs. 700 and 800 per kg . Therefore the purchase. the cost of spirulina for drug manufacturers was around Rs.750/kg. However, spirulina made drugs sold at an average price of Rs. 1400 per kg. The selling price was on an average Rs. 1.33 per 500 mg tablet i.e. Rs. 2600 per kg. Therefore the gross margin earned by the drug manufacturers was as large as Rs. 1260 per kg of spirulina. This rate of profitability was a signal to the producers of spirulina to expand production and to exploit the potential.

Experience in production and focussed application of spirulina for promotion are presented in Table: 32.

Table: 32.- Experience in production and focussed application of spirulina drug.

Sl.No.	Drug	Company	Expeirnece in production	Focused application by the firm
1.	Nuthera	Tanmed	2	Skincare
2.	Skincare	Medimix [a]	1	Skincare
3.	Natoxid	American Remedies	3	General Health tonic
4.	Recolina	BPRL	3	General health tonic
5.	Reliv	Citadal fine pharma Ltd.	3	Radical Erosion in liver cells
6.	Multinol	New Ambadi Estates Pvt. Ltd. [b]	5	General health tonic
7.	Progen	Spirotech Labs.	3	General health tonic

Note: a) Tablet is manufactured by Sowparnika Herbal Products and Extracts. Chennai and marketed by Medimix.

b) Tablet is manufactured by 21st Century Pharma and marketed by New Ambadi Estates Pvt. Ltd.

On an average the companies have 2.5 years of experience in production of spirulina made drug. This showed that the spirulina market had its beginning very recently. But it had gained momentum as shown by the size of market supply. The major application of spirulina focussed was the general health tonic providing the protein supplement to the human diet. Also due to the presence of phycocyanin it was projected as a skin softening natural product for human skins.

Based on the monthly requirement data, the requirement of spirulina for 2000 A.D was projected. The monthly requirement of spirulina at present was 3 t/month and in 2000 A.D.it would be around 6t/month (projected) by considering the existing firms

would continue to use the spirulina powder at the present rate. The monthly requirement of spirulina showed a steady increase in the last two years (vide Table : 33). As could be seen in the table there was very little seasonal variation. Average requirement per month was varying around 2.50 t/ month.

Table: 33.-Monthly requirement of spirulina powder by user industries (Pharmaceuticals)

Month	Requirement (tonnes)	
	1995	1996
Jan	1.95	2.35
Feb	1.80	2.40
Mar	2.00	2.55
Apr	2.10	2.58
May	2.10	2.62
June	2.5	2.60
July	2.05	2.75
Aug	2.20	2.99
Sep	2.25	2.83
Oct	2.25	2.92
Nov	2.35	2.95
Dec	2.40	3.00

Promotional methods adopted for spirulina drug

The spirulina made drugs found market demand as protein suppliers. They were promoted by various methods and by explaining the various applications. The major promotional methods in practice and their ranking based on Garette scoring technique is given below in Table : 34.

Table: 34.-Promotional methods to promote spirulina made drugs in practice.

Sl.No.	Promotional Method	Promotional method	
		Mean score	Rank
1.	Ethical method	65.43	1
2.	Advertise in AV cassette, Brochure, medical journal, leaflets etc.	61.00	3
3.	Window display at chemist outlet	64.43	2
4.	Exhibition/Trade fairs	55.72	5
5.	Free sample distribution	59.43	4

The major promotional method adopted by pharmaceutical firm are ethical method in which the products are promoted by the representatives of the company by explaining them in person to the physicians. Physicians inturn create demand for the products. Being an effective method of personal contact these firm would be able to sell the drugs made out of spirulina by explaining the various application for human health. Another method was the window displays at chemist outlet which would attract people and create awareness among them. Even though the cost of marketing for the first method was very high, its effectiveness also was very high - it promoted not only awareness but also a desire to buy. Therefore returns to investment in this method was large as reflected with profit margin estimated to be about Rs.1260 / kg of drug . The other three methods in the descending order of importance were advertisement in audio visuals, medical journal, leaf lets, brochure etc., free sample distribution and participating in trade/fairs.

Animal feed firms

Another area where spirulina found use was the animal feed manufacturing industry, again as protein supplement in animal feed. It met also a part of the vitamins requirement of animals.

The responses of the animal feed manufacturing units surveyed at Namakkal are presented below.

Owing to the high price of spirulina, it was found that the spirulina could be used only for shrimp feed manufacturing. The comparative purchase prices of different protein sources are presented in Table : 35.

Table: 35.-Protein source, percentage of protein present and purchase price of protein for animal feed firms.

Sl.No.	Protein source	Percent protein	Cost of purchase (Rs/t)
1.	Groundnut cake	40	9000
2.	Soya	45	10500
3.	Sunflower cake	24	5300
4.	Rape seed	34	5550
5.	Cotton seed extract	40	6000
6.	Fish meal	40	9000
7.	Meat meal	65	7500
8.	Spirulina	60-65	500000

Compared to other sources, spirulina had high protein content no doubt and good amount of vitamins, minerals also for enriching animal feeds. But the major disadvantage was that the price per unit of protein (Rs.7.000) from spirulina was manifold higher than (about Rs.225) other sources. No rational buyer would go for spirulina. However, there was significant use for spirulina in shrimp feed manufacturing, because the product could bear the high cost.

Therefore any effort to reduce the cost of production of spirulina powder, would help animal feed producers and the market for spirulina would expand.

Market Potential for Spirulina

As already discussed spirulina powder found a ready sales in international market and in pharmaceutical industry, while use in animal feed was small. Current production of spirulina powder was 194 tpa. From 1993 to 1996 production increase from 104 tpa to 194 tpa showing an average annual growth rate of 1.43 per cent over the base year production. If the trend continued into the future production in 2000 A.D would be

$$Q_t = Q_0 (1 + r)^t$$

$$= 194 (1+ 1.43/100)^4 = 205.34 \text{ tpa.}$$

This was the likely supply by 2000 A.D.

What was the likely demand. The off take of spirulina powder in 1996 was

1)	for pharmaceutical firms	:	40 tpa
2)	for export	:	150 tpa
3)	for other uses	:	4 tpa
	Total		194 tpa

If the input output ratio (or in otherwords the spirulina content in the drugs) was assumed to continue to be the same on an average, the demand for spirulina would increase in the same proportion as the growth rate of sales of drugs. It was estimated that the drug industry was growing in terms of physical quantities (tonnes) at an annual rate of 7.8 per cent (vide Economic Survey 1994-95) for the past five years. At this rate demand for spirulina would also grow. If the current share of spirulina production going to pharmaceutical industry could be assumed to have met about 80 per cent of the demand of

the drug firms. Then current demand for spirulina for use in drugs would be 40 x 100/80 = 50 tpa. If it grew at 7.8 per cent per annum the demand by 2000 A.D. would be:

$$Q_{2000} = Q_{1996} (1+ r/100)^t$$

where,

$$r = 7.8 \text{ per cent} \quad \text{and} \quad t = 4$$

$$= 50 (1+7.8/100)^4 = 72.79 \text{ tpa}$$

Second component of the demand for spirulina was export. The quantity exported in 1996 was 150 tpa. Export of spirulina in 1993 was 59 tpa and it worked out to 26.27 per cent. If the trend continued for the next five years the export demand for spirulina powder could be estimated by using the above formula.

$$E_{2000} = E_o (1+r/100)^t$$

$$= 150 (1+ 26.27/100)^4 = 481 \text{ tpa.}$$

Data was not available to made similar estimate for the demand for spirulina powder by animal feed firm. As a rough measure it could be assumed that it would be in the same proportion (2.06 per cent) as in 1996 in the total sales.

Then demand for animal feed industry by 2000 A.D. would be (72.79 + 481.0) x 2.06/97.94 = 11.65 tpa.

Adding up:

Demand for pharmaceuticals	:	72.79 tpa
Demand for export	:	481.00 tpa
Demand for other uses	:	11.65 tpa
Total		565.44 tpa

Therefore, the total market demand for (domestic and foreign market) for spirulina powder would be 565.44 tpa by 2000 A.D. against the likely supply of 205.34 tpa. Therefore, the spirulina producing firms had a good market potential to tap, even on the assumption that the current trends would continue in the future.

However, it might be possible to create more demand by sales promotion methods and technological changes to reduce the unit cost of production. Therefore, market potential for spirulina powder was high and the current level of production need to be doubled at least. Creation of additional capacity and improvement in capacity utilization rate would help the expansion of production.

SUMMARY AND CONCLUSION

CHAPTER VI

SUMMARY AND CONCLUSION

In this chapter a brief summary of work done, statistical tools applied and results are presented, conclusions are drawn and their implications for spirulina producing firms are stated.

The Focus

Industrial application of single-cell protein produced from the microbes like yeast, bacteria and algae is good source of protein supply not only to human beings but also to animals and fish. Among them spirulina a cyanobacterial single-cell protein from the algae family is gaining importance among the products in health market as a protein supplement in diet. Presently it is used an a source for production of protein enriched health drugs. It was a growing market. Hence a study on the market potential for spirulina was taken up to identify the needs in development research and commercial production. The study had the following objectives:

(i) to estimate the demand for spirulina as a source of raw material for pharmaceutical products and animal feed in Tamil Nadu;

(ii) to identify the factors determining the demand for and supply of spirulina powder;

(iii) to find the market feasibility for spirulina in Tamil Nadu:

(iv) to formulate a suitable market entry strategy; and,

(v) to calculate the Cost of Production and return on investments for spirulina powder.

Study Area

A pilot survey was conducted. It showed that pharmaceutical units were the major users of spirulina powder followed by animal feed manufacturers and shrimp feed manufacturing. The producers of spirulina, the pharmaceutical units and animal feed manufacturing units were considered for the present study. The study area was selected on the basis of distribution of major users of spirulina powder, and the location of producing units. The list of producers of spirulina was obtained from CFTRI, Mysore and the lists of pharmaceutical units and animal feed units were prepared from Pharmaceutical and Drug Manufactures Association and Namakkal Animal feed Manufacturers Association respectively. It was found that in Chennai, there were about 139 pharmaceutical units which constituted 71 per cent of total number of units in Tamil Nadu and hence it was decided to take up the survey in Chennai. Similarly for animal feed firm it was decided to conduct survey at Namakkal.

Methodology

The study required information on spirulina production and spirulina consumption. This required collection of data from spirulina producing firm and from pharmaceutical and animal feed firms.

As regards to spirulina production three firm were contacted and details pertaining to production were collected.

For details on spirulina consumption 30 pharmaceutical firm (21.6 per cent of total) in Chennai and 15 animal feed firm (19.2 per cent of total) were contacted and data were collected by personal interview method with the help of separate, pretested comprehensive enquiry schedules. This primary data were the major source of information for the study. Some limited information available from secondary data was also used.

Findings

The data were analysed with reference to the objectives set for the study and the results were discussed to draw specific inferences. Salient findings are briefly reported hereunder.

Economics of production

In this part of analysis, various issues relating to spirulina production, distribution of production units, capacity utilization, the economics of production and problem in production were analysed.

Source of technology know how and research centers for spirulina are located at CFTRI, Mysore and MCRC, Chennai. Major Commercial Plants in South India are Ballarpur Industries Ltd., New Ambadi Estates Ltd. and Parackal Farm Private Ltd. Out of these three firms, one firm utilizes 80 per cent (120 tpa) of capacity installed, another is using 60 per cent (72 tpa) of capacity installed and the third is using 20 per cent (2 tpa) of total capacity. Growth in production over the period 1993-'96 showed an upward trend. It was 104 tpa in 1993 and 194 tpa in 1996.

Factors for Production

The major factor influenzing production were, price of the product, climatic condition prevailing in that area, final product quantity and quality of water used for culturing algae.

The major promotional methods adopted by producers are, (i) direct contact method, (ii) audiovisual method, (iii) participating in exhibition and (iv) market visits. The results showed that direct contact was most effective for sales promotion while other methods were effective in creating awareness. So a combination of them was necessary for successful marketing.

Cost of production

The cost of production ranges from Rs.319.170/kg to Rs.371.167/kg due to difference in the capacity utilization. The cost of production for 10 tpa capacity worked out to Rs.359.55/kg with fixed investment of Rs.45.95 lakh. fixed cost Rs.12.62 lakh and variable cost of Rs.23.335 lakh. However. the market price for the product was in the range of Rs.700/kg to Rs.800/kg. Hence production of spirulina powder was economically viable and highly profitable.

Market Potential

Of the total quantity of spirulina produced nearly 77.3 per cent was exported and 22.7 per cent was sold to domestic market. In domestic market. around 20.6 per cent went to pharmaceutical firms and 2.7 per cent to animal feed manufacturing units.

The pharmaceutical units use spirulina for manufacturing the drugs and promote them as a protein supplement in the human diet. On an average price of spirulina made drugs was Rs.1.33/ tablet of 500 mg content. The requirement of spirulina by these firm was estimated at 3 t/month and by 2000 A.D. it would go up to 6.25 t/month. The cost of production for spirulina drugs worked out to be Rs.1400/kg, while sale price was Rs.2600/kg, leaving a profit margin of Rs.1260/kg of drug for drug manufactures. It allowed them to absorb market fluctuations if any, easily.

In animal feed firm the purchase price of other protein sources was on an average Rs.225 per unit protein as against Rs.7000/unit for spirulina powder. Therefore use of spirulina powder in animal feed was not economically advantageous and that would explain negligible share of these firms in total sales of spirulina in 1996.

Market potential for 2000 A.D.

Therefore the market for spirulina was for export and drug manufacture only. Simple extrapolation of production and market share of export, and domestic demand for drug manufactures indicated a market potential of 564.44 tpa in 2000 A.D., against the projected supply of 205.34 tpa. The gap was the market potential to be exploited, yet.

Policy prescription

A vast research work on spirulina was carried out by Dr.C.V.Seshadri of MCRC, Chennai and Dr.L.V.Venkataraman of CFTRI, Mysore. Eventhough India has pioneered in the research aspects of spirulina, it has yet to come out with large scale commercial production like U.S., Japan, China, etc. This shows a significant lag in transfer of technology. This may be removed by encouraging industry research tie up. The government policy showed be on developing such tie up.

* There is no single bureau/authority to take care of the industry and to provide necessary information to promote the product. So to open a separate cell in the leading institutes like IARI, CFTRI to plan, guide and monitor the growth of spirulina industry.

* Alternatively, it might be possible to develop strong association among the spirulina producers in promoting, the spirulina and spirulina based product. The spirulina should be promoted in other form like colas, wafers, biscuits, chocolates, noodles and other edible form apart from the drug form.

* It is necessary to build up adequate and accurate information on spirulina culture, production and market. Ready to use project plans may be prepared and made available at reasonable cost and with required technical advice to the prospective new entrants to the market for spirulina.

* The price of spirulina protein is found to be relatively much higher than that for other source. The imperative is to develop cost effective technology for production and distribution. The latter would include quality control also. This development would strongly support export for forex earning.

The study conclusively showed that there existed vast scope for food grade and feed grade spirulina but the former deserved priority in the immediate future.

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