

# SUSTAINABLE APPROACHES TO COMBAT MALNUTRITION

## SMALL-SCALE PRODUCTION AND MARKETING OF SPIRULINA

BY URS HEIERLI WITH SUPPORT  
AND CONTRIBUTION FROM DENIS  
VON DER WEID



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## ABOUT THIS PUBLICATION

The photo on the front cover shows the production unit at Madurai (India): 12 women produce some 6,000 grams of Spirulina each day with 40 basins and feed 2,000 children every evening.

This publication is dedicated with many thanks to these hard-working and joyful women and the inspiring support team of Antenna Technologies Madurai. They have done the pioneering work on which this booklet is based.

**Author:** Urs Heierli is an economist (Ph.D., University of St. Gallen). From 1987 to 1999 he served as country director of the Swiss Agency for Development and Cooperation (SDC) in Bangladesh and India. During a sabbatical after this posting he wrote the study 'Poverty Alleviation as a Business' and then worked in the Employment and Income Division at SDC's head office in Berne. In November 2003, he started his own consulting company, msd consulting (Markets, Sustainability and Development), in Berne in order to focus further on the market creation approach to development.

**Scientific advisors:** Denis von der Weid,  
Jacques Falquet, Antenna Technologies Geneva

**Foreword:** Denis von der Weid, President,  
Antenna Technologies Geneva

**Editor:** Paul Osborn, Médiateurs, Netherlands

**Photos:** Urs Heierli

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Antenna Technologies  
29, r de Neuchâtel  
CH-1201 Geneva Switzerland  
[www.antenna.ch](http://www.antenna.ch)

ChildFund India  
22, Museum Road  
Bangalore 500001 India  
[www.childfundindia.org](http://www.childfundindia.org)

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One gram of Spirulina per day can correct malnutrition in a small child in a few weeks. Spirulina can be produced locally in tropical countries and is cheaper than carrots or spinach



# TABLE OF CONTENTS

FOREWORD \_\_\_ 9

EXECUTIVE SUMMARY \_\_\_ 13

## 1

### **SUSTAINABLE SOLUTIONS TO COMBAT MALNUTRITION AS A BUSINESS**

- 1.1. THE EXTENT AND SEVERITY OF MALNUTRITION \_\_\_ 15
- 1.2. FOOD FORTIFICATION OR DECENTRALISED PRODUCTION – PROS AND CONS \_\_\_ 15
- 1.3. LIVING ON THE MARGINS, OR ON PROFIT-MARGINS \_\_\_ 17
- 1.4. THE 'OVOMALTINE' PRO-POOR BUSINESS MODEL, ANNO 1905 \_\_\_ 18
- 1.5. ECONOMICS OF NUTRITION: HIGH PRICES TO PAY, OR CHEAP SOLUTIONS? \_\_\_ 19
- 1.6. DELIVERING NUTRITION: THE PARADIGM SHIFT TOWARDS COMMUNITY INVOLVEMENT \_\_\_ 20
- 1.7. IF IT WORKS FOR WORKING WOMEN: SPIRULINA AS A LOCAL BUSINESS \_\_\_ 22

## 2

### **THE SIMPLE PARAMETERS OF SPIRULINA AS A SMALL BUSINESS**

- 2.1. GREEN AND POWERFUL IN MANY WAYS: MEET SPIRULINA \_\_\_ 25
- 2.2. THE PRODUCTION PROCESS \_\_\_ 25
- 2.3. ECONOMICS OF PRODUCTION \_\_\_ 28

## 3

### **SELLING TO THE POOR, THE RICH AND THE MIDDLE: MARKETING CHALLENGES**

- 3.1. LOOKING AT THE 4 P'S: POSITIONING AND MARKETING SPIRULINA \_\_\_ 33
- 3.2. P#1: DEVELOPING THE PRODUCT \_\_\_ 33
- 3.3. P#2: PRICING \_\_\_ 41
- 3.4. P#3: PLACE \_\_\_ 42
- 3.5. P#4: PROMOTION \_\_\_ 42
- 3.6. MORE Ps: PEOPLE AND POLICY \_\_\_ 43

## 4

### **AND, BY GOLLY, IT REALLY DOES DO YOU GOOD: NUTRITIONAL VALUES**

- 4.1. SPIRULINA AS A RICH PROTEIN SOURCE \_\_\_ 45
- 4.2. SPIRULINA AS A RICH SOURCE OF VITAMINS \_\_\_ 45
- 4.3. IRON, ZINC AND OTHER MICRONUTRIENTS \_\_\_ 47
- 4.4. WHAT SPIRULINA CANNOT DO: COMBATING IODINE AND FOLIC ACID DEFICIENCY \_\_\_ 47

## 5

### **SPIRULINA IN AFRICA: COMBATING MALNUTRITION AND EASING LIVES OF HIV/AIDS VICTIMS**

- 5.1. THE STATE OF AFFAIRS OF SPIRULINA IN AFRICA \_\_\_ 49
- 5.2. IMPROVED QUALITY OF LIFE FOR HIV/AIDS-AFFECTED PEOPLE \_\_\_ 49
- 5.3. RE-THINKING FOOD AID TO FIGHT HIV/AIDS \_\_\_ 49

## 6

### **TOWARDS A NEW BUSINESS MODEL FOR SPIRULINA IN DEFEATING MALNUTRITION**

- 6.1. THE COST ADVANTAGES AND DISADVANTAGES OF SPIRULINA \_\_\_ 53
- 6.2. MAKING 'BUSINESS BIG' – IS SCALING UP WITH 40 MADURAI CENTRES A DREAM? \_\_\_ 53
- 6.2.2. INSTITUTIONAL SETUP: NGOS AND A MARKETING COMPANY \_\_\_ 54
- 6.2.3. ORGANISING FOR THE MARKET PLACE BY CREATING A MARKET DEVELOPMENT COMPANY \_\_\_ 55

6.2.4. ECONOMIC VIABILITY AND PRODUCTION COSTS	55
6.2.5. PRODUCTION SETUPS AND INVESTMENT COSTS	57
6.2.6. INVESTMENTS AND RETURNS FOR A SCALING-UP PROGRAMME	58
6.3. FROM THERE TO MASSIVE SCALE: SPIRULINA TANKS INSTEAD OF COWS?	59

# 7

## OTHER BUSINESS-ORIENTED APPROACHES TO COMBATTING MALNUTRITION

7.1. MILK IN SO! MANY WAYS: HAGAR SOYA, CAMBODIA	61
7.2. IDE'S HORTICULTURE PROGRAMME FOR HIV/AIDS VICTIMS IN ZIMBABWE	65

ENDNOTES	67
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## ANNEX

### SPIRULINA AS A FOOD COMPLEMENT FOR HEALTH AND COGNITIVE DEVELOPMENT BY DENIS-LUC ARDIET AND DENIS VON DER WEID

1. INTRODUCTION	73
2. NUTRIENT DEFICIENCIES IN INDIA: SOME FIGURES	73
3. NUTRITIONAL NEEDS FOR MENTAL DEVELOPMENT DURING LATE PREGNANCY AND THE FIRST TWO YEARS OF LIFE	74
4. COGNITIVE DEVELOPMENT AND CHILD STUNTING	77
5. INFECTIONS AND COGNITIVE DEVELOPMENT	77
6. FOOD FORTIFICATION WITH SPIRULINA AND CHRONIC MALNUTRITION: STUDIES AND EVIDENCES	78
7. RECOMMENDATIONS AND CONCLUDING REMARKS ON SPIRULINA'S BENEFITS	78
8. SCIENTIFIC LITERATURE	79







# FOREWORD

Halving our world's number of victims of hunger and malnutrition (in absolute terms from 800 million to 400 million) in the space of two decades is a recurrent contemporary political goal, a sadly familiar feature on our horizons of concern. It was decided upon by 180 heads of state at the World Food Summit in Rome in 1996; their deadline, our deadline: "not later than 2015". The Millennium Development Goals, also for 2015, adopted by the UN General Assembly in 2000, have a similar objective. Today, we already know that this objective will almost certainly not be reached, notwithstanding some great advances in some countries, in the Caribbean and Latin America in particular. In October 2006, the FAO estimated that, in absolute numbers, "842 million people suffer chronic hunger. In 19 developing countries, the number of hungry dropped by 80 million over ten years. But in developing nations overall, hunger is on the rise".<sup>1</sup>

A Plan of Action is not always supported by political will. Political forces and their international Institutions do not, it seems, consider hunger as intolerable and as a major human problem. Malnourished children are not seen as future voters and many politicians appear to have other priorities. The food industry was also not interested in fighting malnutrition, in the past at least, as this struggle has not seemed to be profitable. But is this really true? Are there no viable solutions to end malnutrition?

This publication shows sustainable and profitable ways of combating malnutrition, and the aim is to open the debate and to find innovative financial solutions.

It is reliably estimated that, today, 250 million children are suffering from malnutrition. Numerous studies of nutrition, worldwide and at regional and at local level, together present a dramatic picture of low birth weight, prevalence of micronutrient deficiencies, insufficient daily food intake and physical and mental retardation of infants and children.

Around 60% of women in south Asia are underweight. This is one of the main reasons why over 50% of children in Asia are also underweight. The vicious cycle is clear in India where the undernourished child population between 0 to 6 years is estimated to be 85 million; almost half the children under 3 years are underweight or stunted. Slum children are the worst in nutritional profiles.

One other vicious cycle lies in the interactions between under-nutrition and disease, with grave economic and public health consequences.

On the economic front, the World Bank recognises that the continuous failure to tackle malnutrition is preventing success in public health efforts and poverty reduction. It has also provided unequivocal evidence that workable solutions to the malnutrition problem can be "excellent economic investments...". Warning that "malnutrition is costing poor countries up to 3% of their yearly GDP", the Bank has emphasised that "malnourished children can lose more than 10% of their lifetime earnings potential..."<sup>2</sup>

It is this calamitous situation and its well-documented indicators that has led Antenna technology, a Swiss-based NGO (Geneva) composed of scientists and researchers, to determinedly find an efficient solution for defeating child malnutrition. Today Antenna works in 12 countries introducing Spirulina as a tool to fight child malnutrition for the extremely poor. Clinical studies in India and Africa have shown that, when Spirulina is used as a food complement, there is a significant response in the improved nutritional status of undernourished children.

This book undertakes a comprehensive financial analysis of Spirulina production and marketing, with special reference to India. It shows that Spirulina is a sustainable and economic solution to malnutrition. It should also be clear malnutrition is not a market suitable for quick profits.

Lately, governments and large agribusiness enterprises have been interested, in a rather haphazard fashion, to develop these markets at 'the bottom of the pyramid'. True, we need a business-like approach, but in a new, socially-oriented framework and not one of market expansion. We believe we have found it. Antenna has sought to test a feasible production model providing employment for rural women and allowing the fruits of its research and practical experience to be shared with the most vulnerable and disadvantaged people.

We fixed a number of criteria to promote a strategy for a progressive agricultural project which:

- ensures that Spirulina can be produced locally
- uses inputs of common agricultural ingredients
- uses Spirulina production as an employment opportunity for women
- develops a low cost solution to fight malnutrition
- ensures economic self-sufficiency and sustainability.

Spirulina production can help to improve local food security and sustainability. Its function can be compared to the kitchen garden, which is an efficient tool to ensure

local food security. Improved nutrition in general and micronutrient intake in particular is the most effective antipoverty instrument. It has an impact for the whole life of the child, throughout adulthood. Indeed, investing in local Spirulina production is one of the best options for NGOs and UN agencies (such as Unicef, FAO and WFP) in their quest for sustainable nutrition impacts.

There is considerable interest in the use of multiple micronutrient supplementation in developing countries, where diets are suffering from poor quality. Furthermore, infections and parasites impair the absorption or increase the losses of several nutrients.<sup>3</sup> There is a genuine need for further research, and Antenna would be pleased to involve an internationally recognised research Foundation to support a large-scale double-blind randomized controlled trial of Spirulina. The outcome of such trials would provide international credibility to the scientific community. Up to the present day, there has only been lukewarm interest in investing in such natural food clinical trials. Yet micronutrient trials and studies are undertaken by pharmaceutical companies or research centres, but they focus on synthetic products. Spirulina is a 100% natural product and is particularly well-balanced in micronutrient specifications, containing all the nutrients that should receive priority such as iron,  $\beta$ -carotene, thiamine, riboflavin, Vitamins B6 and B12 and selenium.

Our concern for sustainability is expressed primarily in striving for women employment schemes benefiting women from the lowest income groups. It is a proven fact that mothers will feed their children well if they can and if they are aware of what they need. Linking Spirulina production, marketing and even feeding programmes to local income-generation and microfinance schemes such as Self-Help Groups is a far better option than distributing subsidies. Since malnutrition is today a major public health problem and given that Spirulina has a crucial role to play in this context, the proposed local production and marketing setups could become a model to solve these problems. If this proposed system works efficiently, we have every reason to hope that international agencies and NGOs will accept the challenge and recommend this solution as an answer to the right to micronutrient food.

Experience in Africa have shown the efficiency of Spirulina mixed with such cereals, as sorghum, soy or maize. Such a product mix ensures synergetic interactions between calorific intake and micronutrient deficiencies. A similar solution exists with high nutritional value biscuits like the traditional chikkies in India. Today chikkies with Spirulina added are already locally produced and sold widely.

Since "a child who is stunted at five years of age is likely to remain stunted throughout life"<sup>4</sup>, it is of paramount importance to find sustainable and simple solutions. There is enough nutritious food in the world, but the hungry and malnourished can only hope and improve their daily food needs if they produce at least part of the food locally themselves. Sustainable approaches with economic independence form the new and innovative concept that local Spirulina production can provide.

This book adequately demonstrates the value and feasibility of Spirulina and its local production. Needless to say, this economic demonstration would not have been possible without the support of Urs Heierli who, with his perceptive understanding of Antenna technology's objectives, accepted to share all the significant contributions made by Antenna Trust India.

Our profound thanks are also due to the scientific adviser of Antenna Technology, Jacques Falquet, for his permanent advice, especially on the scientific aspects of Spirulina cultures. We wish to deeply thank all the private donors and foundations in Switzerland – in particular France Majoie Le Lous, Martin Pestalozzi and the Stanley Thomas Johnson Foundation in Berne – and SDC, the Swiss Agency for Development and Cooperation, who have supported our concept and Indian projects for some time. Finally, and in particular, we sincerely and directly thank all the members of Antenna Trust in Madurai who have worked so much for the last 10 years. Your diligence has shown, so convincingly, how Spirulina production can be sustainable and its distribution to the poorest can efficiently defeat child malnutrition. We thank each and every one of you.

Denis von der Weid, Antenna technology  
November 2006

1 'The State of Food Insecurity in the World 2005'. FAO, Rome. 2006

2 available online at: [www.worldbank.org/nutrition/Resources](http://www.worldbank.org/nutrition/Resources)

3 Friis H., Michaelsen K.F., (1998) Micronutrients and HIV infection: European Journal of Clinical Nutrition 52: 157-163

4 What Works? A Review of the Efficacy and Effectiveness of Nutrition Interventions, Lindsay Allen, Stuart Gillespie, Asian Development Bank, September 2001





## EXECUTIVE SUMMARY

It may appear to be a cynical statement but, sadly, it is a true one: people living as refugees in a refugee camp face a lesser risk of malnutrition than in their normal daily struggle for survival outside. The vicious cycle of anaemic mothers who give birth to underweight children and then cannot give them enough proteins and especially not enough micronutrients is a '**silent massacre**'. Malnourished children do not cry; they will just grow up mentally retarded, stunted or even blind. If malnutrition occurs in combination with diarrhoea and/or malaria, this may lead to high infant mortality rates.

In the combat against malnutrition, **sustainable solutions** are essential – not only in emergency situations but also in people's daily life. They are badly needed, not only to achieve the Millennium Development Goals but also as an investment in a productive society. How can a society end poverty and achieve prosperity, if its children are stunted, mentally retarded or too weak to attend school?

One such sustainable solution is Spirulina, a blue-green algae which can serve as a vital source of nutrition. Its major facets include:

- it is **cheap** (the cost of feeding one child in India is less than US\$ 10 a year);
- it is **effective** (requiring only one gram a day);
- it uses a **simple and well-known technology**;
- suitable for **production and processing in decentralised rural industries**, thereby creating **income** for women in rural areas, where most of the world's poor live.

Spirulina is a very interesting food supplement indeed combining the vitamins, iron and many other micronutrients that the body needs. In the case of Vitamin A and iron – the two most important micronutrients – Spirulina is cheaper than any other natural product, including carrots and spinach. In India, one gram of Spirulina per day is less costly than the 50 or 100 grams of carrots or spinach which would provide roughly the same amount of micronutrients. This is not an argument against carrots or spinach but, to be realistic, poor children would very rarely get 50 grams of carrots or 100 grams of spinach every day. Another compelling feature of Spirulina is that it improves not only the physical strength of the body but also the **cognitive development** of the child.

Spirulina is also highly relevant for **people affected by HIV/AIDS**: improved and more balanced nutrition can ease their life considerably although it cannot, of course, cure their disease. In West and Central Africa, HIV/AIDS patients are buying Spirulina every day as a dietary sup-

plement. A recent study with children in Burkina Faso has shown that HIV/AIDS-infected children put on weight and grow if rehabilitated with Spirulina.

What makes Spirulina even more attractive is the fact that it can be **produced locally** with little investment. With proper training and capacity building, decentralised production, processing and distribution of Spirulina can be organised as a **small business for women**. With proper funding mechanisms, these same women can be involved in feeding programmes and become sustainable **barefoot nutritionists**. Women who produce, process or sell Spirulina can also become agents of awareness creation and **nutrition education**. The same is true with small production tanks in schools: if school children learn to grow Spirulina and become aware of its nutritional benefits, this is a fantastic opportunity for awareness creation.

A feasibility study for scaling-up production in India has shown that it is possible to run a profitable social enterprise with decentralised production units, combined with centralised marketing and technical support. Profits can be made on sales in the up-scale market (body-builders, diabetes patients, 'joggers') and used for cross-subsidies in the rural market of the poor. Once they are aware of the nutritional benefits for their children and provided that prices are affordable, poor people in India and Africa have shown their willingness to pay for Spirulina products.

From the perspective of project implementation, decentralised local approaches are **more cumbersome to implement than industrialised food fortification** programmes. With the latter, adding micronutrients to staple foods or other carriers like salt, wheat or cooking oil is a very effective and relatively cheap solution per capita. Unfortunately, it is not the answer for rural areas in Africa, Asia and Latin America, where most of the poor live, and where malnutrition is most widespread. Food fortification strategies work well – and have achieved a lot – in industrialised countries, but do not work if people consume their food unprocessed or process their cereals in small village mills.

There are, however, significant **advantages to decentralised approaches**. The most interesting aspect of this study lies not in the Spirulina algae itself and its fame as a kind of 'miracle' product, but that it can be produced, processed and distributed locally, and that even the poor are ready to pay something for it. In emergency situations, it may be tempting for a humanitarian aid agency to distribute imported 'plumpy nut' or therapeutic milk prod-

ucts, free of charge. This may be justified in short-term emergencies, but it becomes doubtful in long-term emergency situations: distributing food supplements freely is an easy but never a sustainable solution.

In the long run, there are no cheaper and better ways to sustainability than creating **local businesses** which make use of the knowledge and skills of local women. A truly sustainable solution will emerge if rural women can be profitably involved in the eradication of malnutrition and, in the process, make a living out of it. Spirulina can become a sustainable long-term solution if programmes can be designed which enable profitable enterprises that are capable of **combatting malnutrition as a business**.

# SUSTAINABLE SOLUTIONS TO COMBAT MALNUTRITION AS A BUSINESS

1

## 1.1. THE EXTENT AND SEVERITY OF MALNUTRITION

Malnutrition is a silent massacre: every year some 11 million children – 6 million of them just five years old or younger – are dying from malnutrition. Many more – according to UN sources some 250 million children – are victims of malnutrition with severe consequences for their physical and intellectual development.<sup>1</sup>

"For several decades it has been known that micronutrient deficiency – the lack of key vitamins and minerals – brings anaemia, cretinism and blindness to tens of millions of people. But the news of the last decade is that these manifestations are but the tip of a very large iceberg.

Levels of mineral and vitamin deficiency that have no clinical symptoms, and what were previously thought to be of relatively little importance, can and do impair intellectual development, cause ill health and early death on an almost unthinkable scale, and condemns perhaps a third of the world to lives lived below their physical and mental potential."<sup>2</sup>

Together with UNICEF, the Micronutrient Initiative – a thematic network organisation – assessed the damage inflicted by vitamin and mineral (VM) deficiency in 80 developing countries, comprising 80% of the world's population. The results, when published in 2004, were described as "sombre":

- Iodine deficiency is estimated to have lowered the intellectual capacity of people in almost all of the nations reviewed by as much as 10 to 15 percentage points.
- Iron deficiency in the 6-to-24 month age group is impairing the mental development of approximately 40% to 60% of the developing world's children.
- Vitamin A deficiency is compromising the immune systems of approximately 40% of the developing world's under-fives and leading to the deaths of approximately 1 million young children each year.
- Iodine deficiency in pregnancy is causing almost 18 million babies a year to be born mentally impaired.
- Folic acid (folate) deficiency is responsible for approximately 200,000 severe birth defects every year in the 80 countries for which "Damage Assessment Reports" have been issued (and perhaps as many as 50,000 more in the rest of the world). The deficiency is also associated with approximately 1 in every 10 deaths from heart disease in adults.

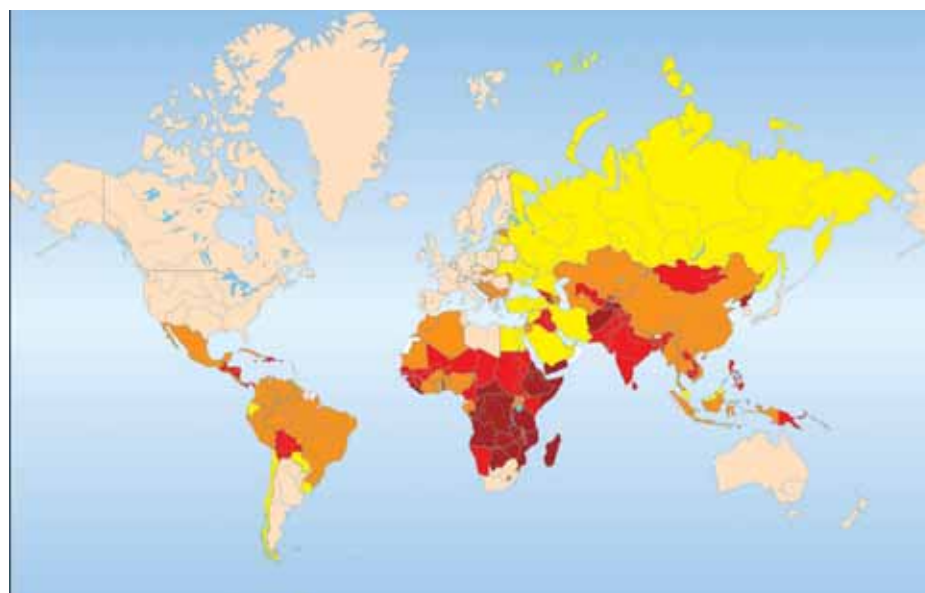
- Severe iron deficiency anaemia is also causing the deaths of more than 60,000 young women a year in pregnancy and childbirth.
- Iron deficiency in adults is so widespread as to lower the vitality and energies of nations and the productivity of workforces – with estimated losses of up to 2% of GDP in the worst-affected countries.
- "Vitamin and mineral deficiencies," says the World Bank, "impose high economic costs on virtually every developing nation."
- In practice, vitamin and mineral deficiencies overlap and interact. Half of the children with VM deficiency are in fact suffering from multiple deficiencies – adding an immeasurable burden on individuals, on health services, on education systems, and on families caring for children who are disabled or mentally impaired.

## 1.2. FOOD FORTIFICATION OR DECENTRALISED PRODUCTION – PROS AND CONS

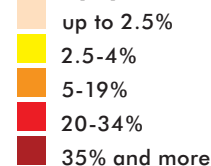
Fighting hunger and combatting malnutrition are high on the agenda of the Millennium Development Goals. The first Goal – of halving hunger by 2015 – "**can be done**",<sup>3</sup> as the UN Millennium Project's own report emphasises, whilst underlining the need for the political will to do so. In earlier development strategies, hunger was mostly related to a caloric deficit. Then it came to be seen as a protein deficit and only recently has it been perceived as a micronutrient deficit. The report pays special attention to the problems of chronic malnutrition of vulnerable groups.

How have developed countries solved this problem in the past? In 1921, when a study in the city of Zurich revealed that "90% of schoolchildren suffered from goitre, the government of Switzerland became the first in the world to recommend iodine supplementation – either by weekly tablets or by consuming iodised salt."<sup>4</sup> Soon, many other countries followed and paved the way for massive **food fortification efforts**: Vitamin A and D was added to milk and margarine. About 25 to 50% of Vitamin A in the diet of the average European now comes from fortified products. In 1938, President Roosevelt signed into law the requirement that US maize, wheat and rice products (including breakfast cereals) should be fortified with iron, thiamine, riboflavin, and niacin.

While the diet of an average millionaire is usually well-balanced and will hardly leave any room for malnutrition,



**Number of people under-nourished in % of total population**



copyright Caritas Switzerland, WFP and FAO

World hunger map : there is a strong correlation between hunger, nutrition and poverty. The map for micronutrient deficiencies is almost identical to this map based on lack of calories

the incidence of hunger and malnutrition – including the large number of severe obesity cases in the USA – is very closely linked to poverty. **Hunger is the result of poverty, and poverty is the result of hunger and malnutrition.**

However, malnutrition does not simply disappear with economic development : "In South Asia, malnutrition rates are higher than would be expected given food availability and per capita GNP, a phenomenon sometimes termed the 'Asian enigma' according to a study by Susan Horton. In seven low-income countries, Horton estimates that there are some 120 million malnourished children. "Rates of micronutrient malnutrition in low-income Asia are also very high. In South Asia, around 60 % of pregnant women are anaemic, and the rate is not much lower for infants and children".<sup>5</sup>

At the other end of the nutrition spectrum, malnutrition – not to be confused with undernutrition – also occurs where there is over-consumption and obesity.

The statistics seem truly incredible, but it is estimated that "fully half of the human family, some 3 billion people,

suffer from malnutrition of one form or another"<sup>6</sup> as the table ( see bottom of the page) compiled by the World-watch Institute shows.

#### **What viable solutions are available for combatting malnutrition in developing countries ?**

The simple path of food fortification does not work in a contemporary developing country. Even with the best intentions, government decrees for compulsory food fortification would not succeed, for the simple reason that the most vulnerable groups do not eat – or cannot afford – breakfast cereals or other industrially processed foods. The World Food Programme (WFP) distinguishes basically two situations – 'life' or 'growth' – each with two types of interventions <sup>7</sup>:

1. "To save the lives of people caught up in humanitarian crises, through **Food-for-LIFE**"; these emergencies can be addressed through "general food distribution" and through "selective feeding programmes". The latter can again be separated into "supplementary or therapeutic feeding" programmes.

#### **Types and effects of malnutrition, and number affected globally, 2000**

Type of malnutrition	Nutritional effect	Number affected globally (billions)
Hunger	Deficiency of calories and protein	At least 1.1
Micronutrient deficiency	Deficiency of vitamins and minerals	2.0-3.5
Overconsumption	Excess of calories often accompanied by deficiency of vitamins and minerals	At least 1.1



2. "To support the most vulnerable people at the most critical times of their lives, through **Food-for-GROWTH**"; these programmes can be divided into vulnerable group feeding (mother and child health programmes) and school feeding programmes. The vulnerable group programmes have a clear developmental goal and are addressing chronic issues.

Yet the tools of response are not the tools of prevention, and even the latter have no universal application. Whereas the classical instruments of food aid interventions are quite well-known and are suitable for the case of emergencies with its strict boundaries, innovative approaches for addressing chronic malnutrition still need to be found. Even if vitamin or iron tablets were to be given during mass campaigns such as vaccinations, it would not be a sustainable solution.

Instead, as the WFP explained to the United Kingdom-sponsored Commission for Africa in 2004, "the key to long-term nutritional improvement lies in **family and community action** to prevent malnutrition". The path to combat malnutrition through better information and awareness, and through solutions which involve communities and give women and mothers an empowered role, is more difficult and cumbersome than the logistical challenge to distribute tablets to an entire population. Mind you, it may be the only sustainable and feasible way to go.

It is in this context that the approaches presented below involving Spirulina should be seen. Some allow local production, the involvement of women and the creation of sustainable jobs. Thus they tackle the challenge of combatting malnutrition by creating a **sustainable business for people**.

The properties and uses of Spirulina are discussed at length elsewhere. Here we shall simply encapsulate the benefits of the use and local production of Spirulina from three complementary angles :

1. Spirulina as a natural product provides a **comprehensive solution to malnutrition**. It contains most critical micronutrients even (though, it must be noted, not all and it is by no means a miracle solution). With just **one gram per day** being enough to correct a malnutrition of a child in a few weeks, it is also an effective solution.

2. Spirulina is a relatively **cost-effective solution**, even if the prices of artificial vitamins, minerals and other food fortification additives are very low. In India, one women's group is producing child-feeding products for slightly more than **one Rupee per child and per day** (or around US\$ 6 per child per year) including the costs of distribu-

tion. Micronutrient supplementation programmes usually cost US\$ 2 to 5 per year. If they are community-based and if the feeding programmes are more intensive and accompanied by awareness creation, then the cost goes up significantly. ECHO, the humanitarian office of the European Union, finances supplementary feeding programmes at the rate of € 9 per child per month (the equivalent of more than US\$ 100 per child per year)<sup>8</sup>.

3. Local Spirulina production can become a **viable business for a group of entrepreneurial women** and can thus create sustainable employment, income and also establish a profitable supply chain for feeding programmes. If the same women who are producing and distributing Spirulina-based feeding products **can make a living out of combatting malnutrition**, they can also play a role by providing continuous information and awareness creation. This is only possible, however, if Spirulina production is supported by adequate **marketing strategies**.

### 1.3. LIVING ON THE MARGINS, OR PROFIT-MARGINS

Since the term 'business' is sometimes misunderstood as meaning 'to take profits' rather than the meaning of 'enterprise' in the sense of 'a viable undertaking', the issues of business and charity are sometimes seen as being in conflict, especially in such life-and-death contexts as malnutrition.

One thing must be very clear: we are not saying that combatting malnutrition as a business is a gold mine and another smart way to extract money from the poorest of the poor. Of course not. Severely malnourished children and mothers will never be able to pay all the costs involved in feeding programs. In order to improve the daily diets of the poor, someone will have to meet the costs, in part through cross-subsidies to combat chronic forms of malnutrition.

'Making a business out of malnutrition' sounds like squaring the circle. At one extreme, there is the danger that it might threaten an enterprise's economic viability by being too generous to the poor. At the other, there may be a temptation to market nutritious products successfully and to forget about the poor.

The approaches presented below have two advantages: first, they are very cost-effective, and secondly, it is possible to build up sustainable production and distribution with very small investments. It is even possible that poor clients can participate in bearing the costs. We shall discuss financing models in connection with microfinance schemes that make the fight against malnutrition more affordable, even for poor people. The dilemma between public health

goals and hefty profits has existed for many decades, even centuries. It is more than one hundred years ago that the famous Dr. Wander created 'Ovomaltine' – widely known in the English-speaking world as 'Ovaltine' – and struggled with the dilemma for the rest of his life.

#### 'Sitting on a gold mine'? How the diabetic doctor got convinced:

Antenna Trust in Madurai was convinced that Spirulina would help diabetic patients in their daily struggle. They approached a well-known diabetic doctor and were invited to several sessions of the diabetic society. They had a small booth and sold Spirulina products to the patients who seemed to appreciate the product.

One day, the booth was shifted towards the toilet and Antenna Trust could hardly sell anything more.

Later, they discovered that the doctor had created a Spirulina capsule factory and had started to prescribe his own "brand" of Spirulina to his patients. While industrial second-grade Spirulina can be bought at a cost of US\$ 8, one capsule of 500 mg sells for close to 2 Rupees, equalling more than US\$ 90 per kg.

#### 1.4. THE 'OVOMALTINE' PRO-POOR BUSINESS MODEL, ANNO 1905

It was with a very clear and single-minded motivation that the Swiss chemist, Dr. Georg Wander, founded the Ovomaltine<sup>9</sup> company – producer of Ovaltine, as the product is generally known in the English-speaking world. He wanted to develop a product which could combat widespread malnutrition among children in Switzerland. During his studies in Germany, he had admired the work of Professor Justus Liebig, a famous chemist whose many achievements had included the extraction of malt under vacuum, leading to Liebig's malt extract soup and other nutritious products especially designed for children and elderly people. Wander improved upon these extraction methods further. He developed a range of malt extract products which could be enriched with chemical fortification agents such as cod liver, iron, calcium, quinine and iodine. Malt is the product of a cereal, usually barley, which is germinated and then immediately dried before the plant develops.

Just one small problem: the product of Dr. Wander's elegant design was anything but elegant! Malt products were **disgusting**: foul to the tongue, they had a bitter taste and a dark, unappetising appearance. At first, nobody really liked the malt products and he added various

ingredients to try to make them more popular. Success finally came when he mixed the malt into some sweets. But even that had a downside too: he was always followed by a crowd of children on his way from his home to the factory and back, hoping for a candy from the famous doctor!

Together with his son Albert, Dr. Wander tried out many mixtures and ingredients in their laboratory. The breakthrough came when they developed the now-famous 'Ovomaltine', a mixture of malt extracts plus eggs and cocoa milk which neutralised the bitter taste of the malt. The added products of milk and eggs increased the nutritional value further and the vacuum technology allowed a low-temperature processing which preserved a high amount of vitamins. The eggs added value to the name too, by integrating the Latin word for egg ('ovum').

Ovomaltine soon became very successful: in 1905, 20 tons were sold; 50 in 1906 and 100 tons in 1907.

Initially, Wander had wanted to position Ovomaltine as a product to combat malnutrition in anaemic children and he stressed – above all others – the medical values of the product. It was marketed in pharmacies and every fortnight Dr. Wander sent a newsletter to 3,700 medical doctors. This strategy was not without success, but one major problem was the image it created. Ovomaltine was perceived as a product for 'the sick' and for poor anaemic women and children. It did not appeal to the healthy middle classes who felt that Ovomaltine was not made for them.

After 1922, the marketing strategy was completely changed. Ovomaltine was sold through groceries and other retail shops. Instead of positioning Ovomaltine for the anaemic poor, it was promoted as a product providing **health, strength, beauty, success and happiness, and hence as a product for everybody**. Soon, it came to be promoted as food for sportsmen, and the Ovomaltine Company became the key promoter for many such sports events as the 'Tour de Suisse' cycle rallies, skiing events, ice-hockey matches and even army sporting events. This paved the way for a global expansion of the company and a global marketing of the product, always associated with sports, exercise and wellness. In 1953, shortly after climbing Mount Everest, the Nepalese Sherpa Tensing visited the Neuenegg factory near Berne – many Himalaya expeditions naturally used Ovomaltine on their strenuous treks. In 1962, the young Brazilian footballer Pelé joined the growing list of endorsing sports stars.

Today, in its second century, Ovomaltine has become a global brand in nutritious products. It is still a major player in food fortification; not only sportsmen, but also

the Swiss army use Ovomaltine regularly as a complementary food. Despite stiff competition, Ovomaltine has won its place on many breakfast tables, and is popular as a bed-time drink.

In its long history, Ovomaltine's widespread consumption undoubtedly contributed significantly to reducing malnutrition, but not without a slightly bitter taste of regret coming from its profitability. It consistently troubled Dr. Wander that the more Ovomaltine conquered the world through outstanding marketing efforts, the more it lost its original social purpose. No longer was it a product targeted for the poor; indeed it was – even in Europe – not always affordable for them. For this reason, Dr. Wander developed a low-cost version under the name of 'Dawamalt' (from Dr. A. Wander Malt), costing less than Ovomaltine. However, it was not a very successful product, and with sadness the famous Doctor could never solve the dilemma between combatting poverty and making profits.

### 1.5. ECONOMICS OF NUTRITION: HIGH PRICES TO PAY, OR CHEAP SOLUTIONS?

In her extensive studies on the cost-effectiveness of investments in nutrition<sup>10</sup>, Susan Horton arrives basically at two conclusions:

- a) "the social costs of malnutrition are enormous"; investments to combat malnutrition are thus very cost-effective and will also pay off in terms of economic growth;
- b) "studies suggest that nutrition investments can be quite inexpensive and replicable on a national scale".

The different options have a wide range of unit costs<sup>11</sup> and Horton stresses that "unit cost information alone is not enough for policy analysis. Impact data is also necessary". Some forms of intervention may be very cheap but not very effective, if the necessary awareness is not spread along the intervention.

From the table below, it is clear that for large-scale solutions, **micronutrient fortification is the cheapest solution** per beneficiary/year: the costs of adding micronutrients to a suitable 'carrier' like wheat or oil, or iodine to salt, are almost negligible and can be borne by the consumers. However, in practice, the situation is more complicated. "For example, in Asia, iron fortification of cereals (one of the most important method used in developed countries) is feasible for wheat-based diets but not cost-effective for rice-based diets. Fortification of vegetable oil with vitamin A is cost-effective in South Asia, but not in South-east Asia and China, where purchases of vegetable oil are much lower. In all countries, there are remote regions that are not tied in to national food markets and are very hard to reach through national-level food fortification programs."<sup>12</sup>

The more the programmes are linked to **information and education**, the costlier they become. All programmes with community involvement cost more than simple fortification programmes but they are also much **more sustainable** and effective. Horton adds that "education programs to change behaviour (for example education of mothers accompanying growth monitoring, or to promote breastfeeding) can be equally cost-effective, if well designed".

#### Approximate unit costs of intervention with effects on malnutrition

Intervention	Cost/beneficiary/year (US\$)
Micronutrient fortification:	
Iodine	0.05
Iron	0.09
Vitamin A	0.05-0.15
Micronutrient supplementation:	
Iodine	0.50
Iron (per pregnancy)	1.70
Vitamin A	0.20
Mass media education programmes	0.20-2.00
Breastfeeding promotion	2.00-3.00
Education programmes (home gardening, growth monitoring, etc.)	5.00-10.00
Community-based nutrition programmes:	
Less intensive	2.00-5.00
More intensive	5.00-10.00 and up
Feeding programmes (per '000 calls/day)	70.00-100.00
Food subsidy programmes (per '000 calls/day)	36.00-170.00

The point about impact is best illustrated by Horton's comment that **micronutrient supplementation** is about 10 times more costly than fortification. Nonetheless, it may reach the target groups much better, especially if accompanied by education and community involvement. Supplementation programmes should be well-targeted at vulnerable groups, especially small malnourished children and pregnant or lactating mothers. In Vietnam, a programme covering 20 % of the population, includes growth monitoring, supplementary feeding, micronutrients (a limited amount of iron supplements for pregnant women), and nutrition education. The programme costs US\$ 2.2 million per year, or US\$ 0.83 per child, or US\$ 12.30 per malnourished child.

Susan Horton concludes: "Feeding programs overall need much work. Unless they are well-targeted and combined with nutrition education, they are not sustainable."

## 1.6. DELIVERING NUTRITION: THE PARADIGM SHIFT TOWARDS COMMUNITY INVOLVEMENT

It is a great challenge to properly target poor and vulnerable groups in order to improve their nutrition status. Solutions can only become effective if the underlying causes of malnutrition – such as poverty, lack of income, economic and social vulnerability, marginalisation – can be tackled as well. Even if distributing food rations may be – temporarily – a must, it offers neither a long-lasting nor a sustainable solution. In Bangladesh, the agency BRAC, formerly known as the Bangladesh Rural Advancement Committee, has tied its programme for vulnerable group development (VGD) closely to income generation activities and promotes training and skills development – together with food aid as a temporary measure.

"The Income Generation for Vulnerable Group Development (IGVGD) programme covers the poorest women who own no land, have little or no income, are widowed or divorced and with no able bodied male member in the family. The objective of the IGVGD programme is to alleviate poverty of the hard-core poor by providing long-term sustainable income and employment opportunities through food assistance, training and access to credit facilities.

Initiated in 1985, IGVGD is a collaborative programme involving three partners: government of Bangladesh, World Food Programme and BRAC to serve the ultra-poor. Elected local government bodies at the lowest level are also involved with this program. The Vulnerable Group Development Programme (VGD) cardholders receive a monthly ration of 30 kg of wheat for 24 months. BRAC provides various skill training to these women in different

income generating activities, mainly in poultry, goat and cattle rearing and vegetable cultivation. After completion of the 24 months food support cycle they graduate into the Economic Development Programme to become its regular members. With skill training, VGD women become eligible for credit support where no collateral is required. The average size of the first loan is Taka 2,500 (approx. US\$ 40).

During January 2001 to December 2002, 287,350 VGD cardholders received 206,892 MT of wheat, 258,500 cardholders received Skill Development Training and 184,796 cardholders received their first loan as BRAC VO members." <sup>13</sup>

A very interesting initiative has been launched by BRAC and WFP to **involve poor women in the production of local fortification of cereals**. "The programme, operating on a sustainable 'no loss, no profit' basis, uses four village-level hammer mills equipped with a new fail-safe device to prevent overdosing the flour with vitamins and minerals. Women from the Vulnerable Group Development programme are employed to manage the mills. So far, the mills are providing 28,000 very poor families with 25 kg of fortified flour each month for a processing cost of approximately US\$ 20 per ton or US\$ 0.50 per 25 kg bag." <sup>14</sup>

To involve beneficiaries actively in local processing is a new but promising strategy to tackle the problem of acute and chronic malnutrition. It opens up new opportunities to dramatically improve the coverage of the target population. Even in acute emergency situations, the coverage of therapeutic feeding centres (TFCs) has been reported to be very low: sometimes only 4 % of affected people were reached through stationary feeding centres. The negative impacts of low coverage are hidden; children suffer and die quietly in their homes without ever being registered in a programme or seen by local workers." <sup>15</sup>

In order to increase outreach, many humanitarian organisations are discussing community (-based) therapeutic care (CTC) as a new and cost-effective approach to combat malnutrition. In this context, there is also an expanding debate about local production of therapeutic food. This is in comparison to the practice of using 'ready-to-use therapeutic food' (RUTF) which used to be mostly imported and was thus very expensive, especially with heavy transportation and packaging costs.

Whereas the classical therapeutic feeding centres are exactly the same all over the world, "community therapeutic centres (CTCs) must be highly tailored to the context in which it operates; it is more dependent on local staff, and relies much more fundamentally on community participation and the local structures". <sup>16</sup>





The same women who run the Spirulina production unit also feed some 2,000 children in a Madurai slum, every evening



A Chikki-wallah in Mumbai produces Spirulina-enriched chikkies (energy bars with sesame, millet and jaggery - raw sugar)



Spirulina has grown naturally for centuries in the Lake Chad and is used by local people as a food supplement

The need for such a paradigm shift is further underlined, finally, by the HIV/AIDS pandemic: for many HIV/AIDS-affected people, access to healthy nutrition may not save their lives, but it makes their daily life much more bearable.

### 1.7. IF IT WORKS FOR WORKING WOMEN: SPIRULINA AS A LOCAL BUSINESS

In this context, Spirulina and other locally made food fortification products have a great potential, provided these solutions are well-managed, have properly-trained personnel and based on profitable local setups.

The Geneva-based NGO, Antenna Technologies, has created many local production units for Spirulina in Brazil, Burkina Faso, Burundi, Central African Republic, Democratic Republic of Congo, India, Kenya, Madagascar, Mali, Niger and Senegal. One of the most advanced centres is situated in Madurai, India, employing 15 women who produce over 150 kg of dry Spirulina every month.

The local production of Spirulina offers three key advantages over conventional ways of combatting malnutrition:

1. The first – and in the long run the most important – advantage consists of **involving local women** in the production process and **creating a business for them**. If poor women – from the same communities as the target population – can make a living out of combatting malnutrition, these women can become important **extension agents for feeding programmes and for spreading information**. The advantage of combining local production with distribution – using the same women for production and for feeding – is an interesting option to achieve a long-lasting impact.

2. Decentralised production can create employment for some women and at the same time develop **locally acceptable products**. The 'Spirulina chikkies' (a kind of energy bar enriched with Spirulina) are an excellent example of such a local product development. They are the result of the nutritionist of a Mumbai-based NGO working together with a so-called "Chikki-wallah", a shop-owner who produces sesame bars and other products in a very small and simple shop. They have added cardamom in order to neutralise the taste of the Spirulina algae.

3. Local production and distribution of Spirulina is a very **cost-effective way of combatting malnutrition**. The centre in Madurai is feeding 2,000 children every day with a chikki made of Spirulina, peanuts, puffed rice,

jaggery (raw sugar) for less than one Rupee per child per day, including the distribution. This is much less than any imported or centralised supplementary feeding programme can achieve.

There are also three apparent major disadvantages (presenting a challenge to aid agencies) associated with any locally-based system reliant upon community participation. A closer look, however, reveals that these possible disadvantages are at the same time strong plus-points in terms of sustainability:

1. Women's groups will need **considerable support** in training, technology, management and above all marketing skills in order to develop a viable business; decentralised production units may be complemented by a centralised marketing and technical support cell.

2. Although feeding programmes using locally-produced Spirulina may be much cheaper, they will still require substantial subsidies. Combatting malnutrition is a public health task and not a private good, at least for the vulnerable groups. To **manage these subsidies well** and to avoid corruption will present a great challenge for humanitarian agencies, perhaps greater than the challenge of managing flows of imported food?

3. Decentralised production and processing units may be initially more costly to build up and run as decentralised networks. In the long run, they may become **sustainable 'nutrition education centres'** and initial costs will be compensated by a higher degree of sustainability.

This new approach is well worth exploring: in view of the size of the task, more sustainable and more business-oriented solutions are badly needed. What is certain is that conventional approaches will not solve the problem – to experiment and consolidate non-conventional approaches is thus well-justified. Admittedly, one cannot deny the challenge for development – and even more for humanitarian aid – agencies to set up and manage many decentralised units. Yet to have demonstrable confidence in the ability of poor women to manage the problem of malnutrition – in itself a magnificent statement – is the best guarantee for success, provided they have access to everything they need to enable and empower them for the job.







# THE SIMPLE PARAMETERS OF SPIRULINA AS A SMALL BUSINESS

2

## 2.1. GREEN AND POWERFUL IN MANY WAYS: MEET SPIRULINA

Spirulina is an aquatic micro-organism, sometimes referred to, incompletely, as a micro-algae, with exceptional nutritional characteristics. It is easy to harvest and process and has a very high content of micronutrients. As such, it has great potential for combatting malnutrition and for strengthening the immunity of weaker segments of the population such as HIV/AIDS-affected persons. To a large extent, its potential can be compared to the daily dose of cod liver oil which Europeans used to take in their childhood. **One gram of (dried) Spirulina per day can quickly and permanently reduce infant malnutrition, even in an advanced stage.**

The population in the Kanembu region of Lake Chad had discovered this magic food long ago. Despite their poor diets, they have not suffered malnutrition for centuries, not even in lean times, when they solely ate millet with some sauces. For these sauces contained *dihé*, their name for the Spirulina naturally grown and harvested in the Lake Chad. Thousands of kilometres away, near the lakes where Mexico City now dwells, the Mayans added the green *techuitlati* to their diets.

In the 1950s, a strange traditional food was 'discovered' in Chad by a European scientific mission. It took the form of dried flat cakes tinted green with a blue tinge, found in the markets of the Kanembu region under the name of *dihé*. The mission's study showed that this *dihé* came from masses of a unique micro-organism harvested on the surface of highly alkaline ponds and dried on their sandy banks. This microorganism, capable of photosynthesis and reproducing itself rapidly, was *Arthrospira platensis*, known widely as 'Spirulina' because of its spiral filament-like appearance under the microscope. As a cyanobacterium, it is actually closer to being a bacterium than the 'blue-green algae' as which it is widely described<sup>17</sup>.

Analysis of the nutritional properties of Spirulina showed first and foremost an exceptionally high protein content, of the order of 60-70% of its dry weight; it also showed the excellent quality of its proteins (balanced essential amino acid content). According to a survey by Antenna Technologies in 2000, "this early data was enough to launch various research projects for industrial purposes in the 1970s, because microorganisms (yeast, chlorella, Spirulina, some bacteria and moulds) seemed at that time

to be the most direct route to inexpensive proteins – the famous 'single cell proteins'. While finally no single micro-organism fulfilled its promise of cheap protein, Spirulina continued to give rise to research and even increasing production, for this cyanobacterium had many other assets, both nutritional and technical."<sup>18</sup>

### Spirulina mitigates arsenic poisoning

Spirulina has been found to have very good effects on people suffering from arsenic poisoning caused by the recently-discovered contamination of much of the ground-water in Bangladesh. Up to this point, doctors in Bangladesh have been virtually helpless in treating dying arsenic patients.

Bangladeshi researchers conducted a three-month hospital-based study in which 33 patients were given Spirulina and 17 were given placebo doses. 82% of those taking Spirulina showed tremendous improvement.

Experts fear that more than 18 million people are likely to face eventual death from the poisoning, which at acute stages causes liver, lung, intestinal, stomach and kidney cancers.

Source: Dr. Hassina Momotaj and Dr. A.Z.M. Iftikhar Hussain: Effect of Spirulina on Arsenicosis Patients in Bangladesh Presentation prepared for 'Arsenic in Drinking Water: An International Conference at Columbia University, New York, November 26-27, 2001

## 2.2. THE PRODUCTION PROCESS

The scale of Spirulina production ranges from large-scale to very small-scale. Large production units exist in California, Ecuador, India and China; these units use greenhouses and large oval-shaped water tanks ('raceway ponds') where the growing media (water and fertiliser) is constantly moved by pumps or paddle wheels.

Small-scale production is very promising. In Madurai, in the southern India state of Tamil Nadu, a women's group operates 40 tanks of 18 m<sup>2</sup> each. These tanks are made of wooden frames with UV-resistant plastic inlays of around 40 cm height. The tanks need to be stirred manually and harvested and fertilised once a day. The production process is relatively easy and straightforward, but it requires a wide range of skills. A sound system of



Harvesting Spirulina in Madurai



Weighing the wet Spirulina



Pressing the water out



Wet Spirulina cake



A simple extruder for Spirulina spaghetti



...laid out to dry





One tank of 18m<sup>2</sup> yields about 150 grams of dry Spirulina each day. Spirulina needs sunshine and a temperature above 25 degrees Celsius. On a rainy day, the yield drops



Measuring the density of algae growth (left) and weighing the fertiliser replacement mix – how much fertiliser is needed depends on the yield of Spirulina



Adding the fertiliser to the tanks (left); packing 2 gram sachets of dry Spirulina

knowledge transfer and in-depth training are crucial conditions for success. It is quite a labour-intensive process and employs some 15 women for a production of approximately 150 kg per month from the 40 basins totaling 720 m<sup>2</sup>).

This group of women is now well-trained and is ready to take over the entire operation, provided their marketing needs are completely met. So far, they sell the bulk of the production to two NGOs in Tamil Nadu and in Mumbai.

Although there is a high and growing demand for Spirulina from the middle-classes, so far this women's group has not been able to sell their production in the open market. For this they would need a packaging-machine to make 'pills'. With the innovation of chikkies, a kind of 'energy bar', the situation will change. The group will have a product which is attractive to middle-class children – groups who will be able to pay.

It is obvious that the entire process requires thorough training in all aspects of production, fertilisation, processing, management and marketing. However, these women are the proof that it can be done.

### 2.3. ECONOMICS OF PRODUCTION

In India, the investment required for a tank of 18 m<sup>2</sup> in India is roughly 10,000 Rupees (€ 166). One tank produces 144 grams of dry Spirulina a day, enough to feed some 150 infants.

However, to operate economically, one tank is not enough. Central investments are needed: a store room for fertiliser, a drying area and a packaging room. Without access to land, water and a small building, it is not viable to produce Spirulina. A local production centre should therefore be conceived as a small business unit with some infrastructure and some management skills, including an accounting system.

The bulk of the production costs are labour, nutrients, packaging and capital and administration costs. The women of Madurai produce one kilogram of Spirulina at a cost price of € 4-5. This is very competitive and the group manages to also provide a feeding programme of 2,000 children each day for a cost of only 0.44 Rupees per child per day (less than € 0.01).

The total investment for a unit with 30 tanks<sup>19</sup> could be estimated at 1.2 million Rupees or € 20,000.00 as shown in the table 'Investment' on the next page (prices in Indian Rupees, using an illustrative rate of exchange of 60 Rupees = € 1).

Production costs and potential sales are estimated in the table 'Production cost' on the next page (depending on climate, water quality as well). In Madurai, production is possible during some 10 months per year, when there is enough sunshine and a tropical temperature. In the rainy season, production drops due to frequent rains and lack of sunshine; on a rainy day the yields are usually so low that production may as well be stopped.

Depending on the amount of the capital investment and the financing conditions (mainly building and land) it is possible **to produce a kilogram of Spirulina for between €5 and €7**. However, mainly with respect to the capital cost for land and building, there is room for significant savings, and it may be possible in some cases to get better than market conditions for rent and land. The tanks need to be repaired or replaced after some 3 to 4 years. Other equipment may last even longer. Spirulina production appears to be economically very promising, even under strict market conditions.

The profitability of the operation thus depends mostly on the conditions for the capital and – of course – on the marketing possibilities. The key question is at what price can Spirulina be sold? In pharmacies in Madurai, the 500 mg tablets are sold at 20 to 23 Rs for a package of 10 tablets, representing the equivalent of one kilogram being sold at some 4,500 Rupees or € 75 including the costs of packing the Spirulina in capsules and branding the capsules.

This market is served by larger private producers and is geared towards the middle classes. It is a slowly growing niche market, but it seems that – at least in Tamil Nadu – Spirulina is becoming very popular: in almost all pharmacies visited recently, the product was available on stock. It is interesting to note that the same product in Europe or the USA is sold in small flasks with 100 capsules of 500 mg at rates of € 20 to 30; this converts to per kilogram prices of **up to € 500**, of which a lot is eaten up by high marketing costs. Although it is a tough task, marketing Spirulina in the markets of the rich may be a rewarding business, but for this Spirulina needs to be well-positioned as a health and beauty product in the same way as 'Aloe Vera' or other similar convenience food items.

Our goal here is different; it is to operate in what the World Bank has called "the bare bazaar of the poor". For this, the aim must be to sketch out a marketing strategy which brings Spirulina within the reach of those who most need it. It is therefore a question of reaching the vulnerable groups of infants, children and their mothers and making it popular among them – and amongst those who help them to improve their nutritional status. Our aim is not to market Spirulina to the affluent in the way that

mainstream marketing efforts would tend to focus upon, although sales in these markets can provide valuable income for pro-poor marketing. The core objective is none other than to market Spirulina to the poor, the sick and the have-nots.

**Table: Investment**

<b>Investment</b>	<b>In Indian Rupees</b>	<b>In Euros</b>
30 Tanks	300,000 Rupees	€ 5,000.00
Land and building (can vary a lot according to site, some 1,000 m <sup>2</sup> required)	600,000 Rupees	€ 10,000.00
Tools, packaging machine, working capital	300,000 Rupees	€ 5,000.00
<b>Total investment</b>	<b>1,200,000 Rupees</b>	<b>€ 20,000.00</b>

**Table: Production cost**

<b>Production per year:</b>	<b>In Indian Rupees (Rs)</b>	<b>In Euros (60 Rs = € 1)</b>
<b>average of 130 kilograms during 10 month = 1'300 kgs per annum</b>	<b>2,00,000 Rs (13 salaries)</b>	<b>€ 3,333.00</b>
Salaries (15,400 Rs/month for 10 women, incl. social costs)	78,000 Rs	€ 1,300.00
Nutrient (65 Rs/kg) Administration	24,000 Rs	€ 300.00
Amortisation and interest (15%)	1,88,000 Rs	€ 3,000.00
<b>Total cost per annum</b>	<b>4,91,000 Rs</b>	<b>€ 7,933.00</b>
<b>Total cost per kilogram</b>	<b>380 Rs/kg</b>	<b>€ 6.30</b>

## How to grow Spirulina? Extract from the production manual

Temperature is the most important climatic factor influencing the rate of growth of Spirulina. It grows best at 35°C; below 20°C, growth is practically nil, but Spirulina does not die and above 38°C Spirulina is in danger. Growth only takes place in light (photosynthesis), but illumination 24 hours a day is not recommended. During dark periods, chemical reactions take place within Spirulina, like synthesis of proteins and respiration.

Individual Spirulina filaments are destroyed by prolonged strong illumination ("photolysis"), therefore it is necessary to agitate the culture in order to minimize the time they are exposed to full sunlight. Rain is beneficial to compensate for evaporation, but it must not be allowed to cause overflowing of the culture pond. Wind is beneficial for agitating and aerating the culture, but it may bring dirt into it. Artificial light and heating may be used to grow Spirulina, although they are not economical. Fluorescent tubes and halogen lamps are both convenient. Lamps can illuminate and heat the culture simultaneously.

Spirulina thrives in alkaline, brackish water. Any watertight, open container can be used to grow Spirulina, provided it will resist corrosion and be non-toxic. Its shape is immaterial, although sharp angles should be avoided to facilitate agitation and cleaning. Its depth is usually 40 cm (twice the depth of the culture itself). It can be as small as 1 m<sup>2</sup> but 5, 20 or 100 m<sup>2</sup> are more economical. Dimensions are only limited by the necessity of accessing for agitation and cleaning. The bottom should have a slight slope and a recess to facilitate emptying. Two ponds are better than just one, for practical reasons.

The most economical ponds are made of U.V. resistant plastic film of 0.5 mm thickness or more (PVC or polyethylene), with sides supported by bricks or a wooden structure or metal tubes. If termites are present, a layer of dry ash plus a layer of sand should be placed under

the film to protect it. Concrete ponds are of course a good, durable solution where experienced labour is available. Before starting the culture, the cement should be well cured and whitewashed. A greenhouse over the ponds offers many advantages, provided it can be aerated and shaded. As a matter of fact, covering the ponds is practically necessary. Agitation can be manual, with a plastic broom, once every two hours. If electricity is available, aquarium pumps are practical to agitate the surface of the culture (one watt/m<sup>2</sup> is enough). "Raceway" ponds agitated by paddlewheels are standard in the industry, but somewhat outside the scope of this manual.

### Culture Medium

Spirulina can live in a wide range of compositions of water; the following is a convenient analysis:

Anions	Carbonate	2800 mg/l
	Bicarbonate	720
	Nitrate	614
	Phosphate	80
	Sulfate	350
	Chloride	3030
Cations	Sodium	4380
	Potassium	642
	Magnesium	10
	Calcium	10
	Iron	0.8
	Urea	< 50
Total dissolved solids	12847	
Density @ 20°C	1010	g/l
Alcalinity	0.105	N(moles strong base/liter)
pH @ 20°C		10.4

In addition, the solution contains traces of all micro-nutrients necessary to support plant life.







Just as the malt extracts of the famous Dr. Wander, before he could make them palatable, Spirulina in its raw and pungent form can only be sold to those who are already fully convinced of its value. It can be easily mixed with yoghurt or fruit juices, or added to salads, soups and even spaghetti sauces. The new book *La spiruline pour l'homme et la planète* contains many recipes in French.<sup>20</sup>

For a wider, and less convinced market, of 'common customers', one does need to have a fancier and more attractive product. It is not sufficient to just have some home recipes of the 'believer'. So far, product development had been quite lacking, and is an area that merits much attention. Whereas 'aloe vera' is marketed in health foods and added to yoghurts and many other media, Spirulina is available primarily in tablet forms. Very few selective trials with 'Spirulina noodles', candies and other forms have been undertaken so far. All in all, the break-through needed for Spirulina to go beyond a niche product has yet to be made.

So much for the lifestyles market and its challenges. To position Spirulina to those who need it most is even more demanding. Any sound strategy must tackle the key problems of the 4Ps of marketing (Product, Price, Place and Promotion):

1. to have an attractive and suitable **product**;
2. to have an intelligent **pricing** structure which makes it affordable to even the poorest;
3. to design and build up an effective and profitable '**place**' (**supply chain**); and
4. to design and implement effective **promotion strategies**.

### 3.1. LOOKING AT THE 4 Ps: POSITIONING AND MARKETING SPIRULINA

The key question of any marketer is: how do I position my product? Should it be a product for the poor, for the anaemic, or should it be a product for everybody, making infants, children, and their mothers more healthy and strong.

To make a freely distributed nutrition product attractive may be an advantage and – at the same time – a source of headache: if people do not like the product, it may be better targeted to those who really need it, if it is too attractive, it may be more acceptable but the danger may increase that people resell it.<sup>21</sup>

If the objective is to **include sustainability** in approaches to combat malnutrition, then it is not enough just to distribute Spirulina or other micronutrients in a top-down manner free of charge. What is needed is to find a sustainable way to combat malnutrition and **make it so affordable that the poor and even the very poor can at least contribute** to the purchase price of Spirulina-enriched products on a daily or at least regular basis.

This is not an easy task and a balance should be found between a product which is too attractive and one which is not attractive at all. If Spirulina was distributed – free or at a subsidised price – in capsule form, people would probably take them and, quite understandably, re-sell them if the sales price in the local pharmacy is €75 per kg. But Spirulina products should still be attractive enough so that even the poor may at least pay a partial contribution rather than just accept it as a gift. Trying to have even poor people – except in emergency situations – to contribute as customers is part of a new paradigm developed here (see also: Pricing, in section 3.3).

### 3.2. P#1: DEVELOPING THE PRODUCT

"A product is anything that can be offered to a market for attention, acquisition, use, or consumption that might satisfy a want or need. ... Products include more than just tangible goods <sup>22</sup>" says the 'guru' of marketing, Philip Kotler. In this sense, Spirulina should not just be marketed as a green powder: if it is to be accepted as a public health solution, it must be a tangible product **plus** a service in the form of information about its use and usefulness. If children are the 'clients', then the information may mainly go to the mothers, but it is important to pass a **message** together with the product.

In this sense, the product design should – from the outset – include a strategy of **outreach**: the product should not only be easily consumed but also be distributed in a way so that it reaches those people who need it most. The product should become available **through a trusted person** who can identify the needs of malnourished children in villages. Just as with marketing ice-cream through local street vendors with their cycle-carts, a sustainable supply chain should be set up and an information and education channel should be integrated into the product from the very beginning. There lies a parallel in the marketing of insecticide-treated anti-malaria mosquito nets. They would be quite useless if they were just dumped on the



The 'Spirulina chikki' was developed by a nutritionist and a local 'chikki-wallah' in Mumbai. It closely resembles an already popular product and can be easily manufactured locally



Trials by ADRA with bread in North Korea led to a colouring problem with bread (left). The same green effect on sweets (candies) was used creatively in the product design (right)



"Chikkies" are not only easy to produce, package and distribute, not forgetting how easy they are to chew too!





By involving the Spirulina women's group in feeding makes for excellent outreach. Even better if they are trained in basic nutrition and can assist in weighing campaigns



This mother is blind. She is very keen to give her son Spirulina, and hopes he will have a good eyesight. Kids love Spirulina-millet balls; the roasted millet neutralises the taste of Spirulina



These children from a large Mumbai slum get Spirulina chikkies. Many are anaemic and need the feeding supplements badly, as do their mothers

population without any proper information – instead, mobile mosquito net retailers have an important function of awareness creation when they tour the villages on their bicycles. We will discuss this aspect more in detail under section 3.4 on P #3: Place.

#### a) Positioning the product

A product which addresses a need or a want should take the specific needs of malnourished people into consideration: most vulnerable people do not purchase industrially processed food, and thus industrially fortified food will not reach them automatically. It is proposed, therefore, to **position Spirulina products as cheap complementary food rations distributed by 'peer group' women. These women** may not only distribute the food but also **inform** the mothers about its key nutritional values, and thus provide **a service to the communities**. The product idea would consist of locally-produced Spirulina products – such as 'chikkies' – which will be distributed by a network of the same women who could be also trained as **"bare-foot nutritionists"**, for instance as 'weighing ladies' in the villages.

Successful campaigns – such as in Tanzania – have shown that this community involvement is very important to achieve sustainable results and that indeed the awareness creation outweighs the physical nutrition aspects. If people are aware that their children are underweight, and if they know what can be done against, then they will strive for improvement themselves. The UNICEF *State of the World's Children - Report 1998* which has a special focus on nutrition gives the following example:

"In villages across Tanzania, a seemingly modest process began in the early 1980s when villagers, many of them in poor and remote areas, began to track the weight of their children. With financial support from the Government of Italy and day-to-day technical support from UNICEF, the Child Survival and Development (CSD) Programme began in five districts in the Iringa region, eventually reaching more than half the population of the country.

The result was the virtual disappearance of severe malnutrition – and striking reductions in mild and moderate malnutrition. The lives of thousands of children were saved. These improvements were accomplished against

the backdrop of previously high mortality and malnutrition rates among young children that began to climb in Tanzania following the economic decline in the 1970s and 1980s. Of crucial importance was the Government's continued commitment, even during this difficult period, to policies worked out with the full participation of communities and families. This approach was to prove one of the greatest strengths of the CSD Programme."

#### What UNICEF learned about main players

"Malnutrition has many causes and manifests itself in several ways. There is no single, globally applicable solution to the overall problem, and there is no substitute for assessment and analysis done with the full and active participation of the families most threatened by nutritional problems and most familiar with their impact and causes. People who suffer or whose children suffer from malnutrition cannot be passive recipients of programs. If they are not the main players in problem assessment and analysis, then actions to reduce malnutrition are likely to be inappropriate or unsustainable".

State of the World's Children-Report, UNICEF, 1998

#### b) Product specification

Spirulina should be targeted according to the needs of the people and based on an assessment of malnutrition. As a rule of thumb, Spirulina should be prescribed as shown in the table below.

In addition, it is possible to enrich Spirulina with micro-nutrients. Whereas 'normal' Spirulina contains some 600 mg of iron/kg, it can easily be enriched to levels 10 times higher – up to 6,000 mg/kg. This enrichment can take place during the production process by adding iron to the cultivation media; the algae will assimilate this iron and become 'fortified'. A similar fortification can be done with zinc. When zinc is added in the tank basin, the Spirulina algae will absorb it. The advantage here is that over-dosing is not possible: if too much zinc is added, the algae will die.

#### Spirulina: Recommended daily requirements

Vulnerable groups	Daily requirements
Infants (from 6 to 24 months)	1 g of Spirulina every day for 90 days
Children (from 2 to 5 years)	1 g of Spirulina every day, or minimum 90 days
Children (from 6 to 15 years)	2 g of Spirulina every day, or minimum 90 days
Pregnant and lactating mothers	5 g of Spirulina every day
severe malnutrition and HIV/AIDS-affected persons	5-10 g of Spirulina according to their well-being





Product development at the Mumbai nutrition front: locally-made chickies



Spirulina candies produced in India; each sweet contains one gram of Spirulina



Different products are made from spirulina in Europe such as energy bars and even noodles



Spirulina easily costs US \$ 500 per kilogram in Europe or in the US. Will it become a lifestyle product like Aloe Vera?



Preparations are underway for a large-scale test with 1,000 Mumbai slum children, led by paediatrician Dr. Potdar, (right) seen with Dr. Denis von der Weid of Antenna Geneva







The small unit can produce up to 1,000 chikkies per hour at a cost of less than 1 Rupee each



More product trials, here testing a new mix of Spirulina + puffed rice + groundnut + jaggery



With parents' monthly contributions of 10 Rupees, the chikki unit can feed up to 3,000 children daily

Many products are suitable to facilitate the human consumption of Spirulina: it can be added to **milk products** such as yoghurt, soymilk or similar food. It can also be added to cooked food in the form of soups, sauces, rice and other cereals and to breads, biscuits and even noodles. However with Spirulina's very strong taste and a significant 'ugly' green colouring, unless the taste is neutralised – for instance by adding cardamom – people may not like it. The candies shown (on page 34) have used the colouring effect in a creative way.

An outstanding product to disseminate Spirulina is the 'chikki', a kind of '**energy bar**' where the green colour is not at all disturbing. Chikkies can also be produced in a way that the vitamins are fully maintained: the preparation is such that cereals are added to cooked 'jaggery' (raw sugar) only **after cooking**.

A key problem for product development is that cooking destroys the vitamins in Spirulina. This is, however, common to all kinds of food, and is also true with artificial food fortification with Vitamin A. This problem may reduce the suitability of using Spirulina with baked products such as breads and biscuits. Tests have also shown that the green colour may influence the appearance of the bread considerably. (on page 34)

### c) fortification or a separate product?

The advantage of a fortification strategy is that one hooks the food additive to a product which is already in the market and has its own marketing channel. This works very well in industrialised countries, but in developing countries, fortification approaches face two key problems:

a) if Vitamins or micronutrients are just added to a fortified product, the **distribution problem** is solved, but the

**information problem is not**. As with all – industrially – fortified foods, there is no 'agent' who will inform the mothers about the value of the product. This information is, however, an absolute must, because malnutrition has more than one cause and one remedy: for instance, if the child is severely affected by diarrhoea and if this is not treated, then no food additives will work;

b) even food fortification strategies need to involve **local processing plants**, as up to 70% of maize in southern parts of Africa is not milled industrially but in small local mills. It is estimated that maize fortification programmes in Sub-Saharan Africa would increase costs by 300% compared to large-scale industrial fortification, if 70% of the maize were milled and fortified in small mills.

This gives a very attractive 'comparative advantage' to locally-produced or processed Spirulina products as an alternative. The local production of Spirulina chikkies may be done **locally with very little technology and at a very low cost**. The advantage is that those who are involved in this business can also act as a supply chain and as information agents to spread the message. This also implies that production and dissemination should be closely integrated into national and local community-based nutrition campaigns.

**To summarise:** the product should be an easily chewable and distributable item, produced and processed locally with simple technology and not requiring any sophisticated infrastructure or logistics. Spirulina chikkies are a very suitable product, although not the only possible one by far. In addition, the product should be delivered with information, and the advantage of using the local producers as information agents is evident.

### Other natural food complements

Two other natural products which could be promoted to combat malnutrition, as separate products or in combination with Spirulina are amaranth and quinoa. Both amaranth and quinoa can be used for nutritive breads in school-feeding programs. Adding quinoa to rice could produce a highly nutritive staple food. Using locally-grown agricultural products also generates more rural incomes, one of the key solutions to combat malnutrition:

Amaranth has been known since the Aztecs as one of the most nutritive plants, especially in its high content of protein, calcium, folic acid and Vitamin C. It is widely eaten in Central America. Popped amaranth seeds pro-

vide a good source of protein which can satisfy a large portion of the recommended protein requirements for children and can also provide approximately 70% of necessary calories. In addition, a combination of rice and amaranth, in a 1:1 ratio, has been designated as an excellent way to achieve the protein allowance recommended by the World Health Organization. Amaranth has double the lysine of wheat, triple that of corn and equal to the amount found in milk. Quinoa, a cereal grown in the Andes since the time of the Incas, has a nutritional value superior to 'conventional' cereals and is, in fact, superior to milk solids. Calcium and iron are significantly higher in quinoa than in rice, maize, wheat or oats.



#### d) biofortification – putting the vitamins genetically into 'Golden Rice'

There is another dimension to the issue of what food to fortify, and at what point in its production and processing chain. The notion of biofortification – putting the micronutrients directly into the staple food by growing it thus – has come to command much attention in recent years. Since the pertinence of Spirulina as a food supplement can only be properly assessed by taking into account all other approaches of fortifying diets, it is useful to review the state-of-play with biofortification.

"Imagine a new breed of ultra-nourishing crops capable of alleviating malnutrition in even the most hard-to-reach populations – crops such as rice loaded with iron, maize packed with zinc, and wheat strengthened with vitamin A. These staples would need no commercial fortification, and could be grown on family plots throughout the developing world."<sup>23</sup> This is the vision of the "Biofortification Project" of the Consultative Group on International Agricultural Research (CGIAR) which comprises roughly a score of international agricultural research centres and is hosted by the World Bank. "Such crops are no longer imaginary. It is now possible to breed plants for increased vitamin and mineral content, making 'biofortified' crops one of the most promising new tools in the fight to end malnutrition and save lives... The ability exists today to further improve and more widely disseminate these crucial varieties:

- Iron-rich rice (International Rice Research Institute, Philippines)
- Quality protein maize (International Maize and Wheat Improvement Center, Mexico)
- High-carotene sweet potato (International Potato Center, Peru)
- High-carotene cassava (International Centre for Tropical Agriculture, Colombia)."

A similar effort is under way to develop 'Golden Rice, an attempt to enrich rice with vitamin A through genetic modification. Praised as a high-tech solution to deliver vitamin A to the poorest at almost no additional cost, it is heavily contested by environmentalist organisations such as Greenpeace as a Trojan horse to make genetic modification more acceptable.

One of the greatest criticisms so far had been its low vitamin A content so that one would have had to eat several kilograms a day to get the recommended vitamin A intake. Apparently "the latest variety, Syngenta Golden Rice 2, contains 37 microgram of provitamin A per gram, 23 times as much as the first variety". With that, "a typical daily serving of 200 grams should pro-

vide the recommended minimum dose of vitamin A – provided that the pro-vitamin is not destroyed by cooking and can be absorbed by the body."<sup>24</sup>

The latter seems to be very doubtful, as the absorption rate seems to be higher, if the products are cooked, but the more cooking is done, the more vitamins are also destroyed. The advantage of Spirulina is that the absorption rates are very high, even without any cooking. One gram of Spirulina will provide as much vitamin A per day as 200 grams of the latest version of "Golden Rice".

This research is noble indeed and a fine expression of the need for humanity to do whatever possible to find creative solutions to problems of nutrition. What is definitively very tempting with biofortification is its, let us say, '**free delivery channel**'.

People would not even recognise that they now suddenly eat something healthy, and instead of cooking spinach, eating carrots or Spirulina, they would get what they need by just eating their daily staple food.

However, there are also three severe disadvantages to what is proposed here as a product-cum-service:

**1. The free delivery channel provides neither information nor education.** There will be no growth monitoring and no awareness raising. In fact, the advantage of free delivery is also its most important weakness. Very often, malnutrition is caused by diarrhoea, and if a mother does not know that her child will suffer from anaemia after a diarrhoeal attack, and if she is not aware about the importance of hygiene, this automatic delivery channel will not solve the problem.

**2. All these 'technocratic' solutions have the disadvantage of tackling only one problem** (either iron, vitamin A, or zinc) whereas a **comprehensive solution** is required. The CGIAR then also points out that "biofortification makes sense as part of an integrated food systems approach to reduce malnutrition".

**3. Finally, biofortification systems are long-term solutions, even if they are promising. It will take some seven to 10 years to make biofortification seeds available for large-scale dissemination. Spirulina chikkies as a solution are available now.**

**To summarise:** Even if the CGIAR group were to produce fast results, the attractive free delivery channel is also a weakness. A wise man would support the high-tech solution as well as the women and the chikki-wallahs of Madurai, Bombay and the small projects in Burkina Faso and other African countries. Tackling malnutrition imme-



diately would be complementary to finding long-term high-tech solutions.

### 3.3. P #2: PRICING

**Affordability is everything. If the price is right...**

Making a product **affordable to the target population** does not necessarily mean that all the food is given free of charge. Clearly the poorest and most vulnerable groups cannot pay the full cost of feeding supplementation. Yet whatever pricing mechanisms can enable the target population to participate and contribute will almost certainly have two positive effects:

- a) it will increase people's dignity and ensure they do not just depend on external assistance; and
- b) it will actively involve them and increase their mental and physical participation.

This section seeks, therefore, to discuss and develop such new financing mechanisms. They will need to be very efficient, and they should have a great impact and achieve an excellent cost-benefit ratio.

#### **a) introducing a user contribution to feeding programmes:**

Can poor people pay a contribution for feeding their families? One attractive option could be to tie feeding programmes to microfinance projects and self-help groups. If a family is member of a saving-and-credit group, it would oblige them to **feed all children correctly** and pay a regular contribution of say 10 to 15 Rupees (€ 0.16-0.20) per month towards the feeding programme. If, as a result, the children are not malnourished, it would be an excellent investment in their future and the family's economic capacity. Indeed, the family could also be awarded with some incentives, such as easier access to credit if it has a good track record in saving and feeding.

Such models should be studied and further tested. The US-based Freedom from Hunger organisation has successfully promoted so-called 'credit with education' programmes and has shown "preliminary evidence that integrated financial and education services can be effective against hunger and malnutrition"<sup>25</sup>.

It is quite unusual for feeding programmes to ask beneficiaries for a contribution from the families. Obviously, nobody would pay anything to the WFP or an international NGO or a government agency. However, people would not expect to get things free from their neighbours or from the chikki-wallah. In Madurai, the Antenna Trust

has introduced monthly subscriptions of 10 Rupees to their microfinance programme. Initial experiences are most encouraging: people are ready to pay a modest amount for feeding their children well, provided the mothers are fully aware of the risks of their children being malnourished. However, it has been noticed that whereas people are very keen to repay their loans and to avoid defaulting, they are more reluctant to pay the feeding contributions punctually. A remedy for this could be to handover the responsibility for the feeding programmes totally to village women who are members of self-help groups.

However, it is also clear that feeding programmes require subsidies or cross-subsidies. And just as is the case with primary education, nutrition programmes cannot be financed with a one-time up-front investment; their need for financial support are long-term and recurrent.

Many NGOs involved in children's development have created sponsorship programmes for financing long-term recurring costs. Such sponsorships cost anything from one-half to one Euro per day, or typically € 30 per month, for one child. Following a code of conduct agreed by the charity organisations, Swiss regulations now require that such sponsorships should not be personalised but directed to those children who are most in need.

Preliminary calculations on the basis of the Madurai model indicate that a monthly sponsorship of € 30 would finance the recurring costs of feeding some 120 infants, or 80 children or 45 pregnant mothers. Collective feeding sponsorships would thus be highly effective and attractive for private or corporate donors and sponsors. The cost-benefit ratio of such social investments is extremely high and it could be an attractive new sponsorship product for NGOs asking their sponsors to combat malnutrition. Instead of helping one child, a sponsor could sponsor a large group of vulnerable people, focussed on malnutrition. A corporate sponsorship for 1,200 infants, 800 children or 450 pregnant mothers would only cost some € 5,000 per annum.

#### **b) sales on the open market:**

Spirulina should not only be marketed as a product for the poor and for the anaemic: it is very pertinent to sell the products in the open market with a profit. Specialised products could be targeted to up-market consumers such as body-builders, diabetic patients, joggers and morning walkers and reach a health-conscious group of customers.

**To summarise:** the pricing of feeding programmes should be linked to microfinance programmes and ask for a

self-contribution of the beneficiaries, wherever appropriate. New sponsorships could be developed for collective feeding programmes as attractive new products for NGOs to provide to their donors. One part of the production should be targeted to health-conscious groups of affluent customers on the open market, maybe in different packaging and as a branded product.

### 3.4. P#3: PLACE

Place is related to 'supply chain' and the means for delivering the products; it is the place where people can find what they need. It has already been mentioned that there is a paradigm shift from stationary therapeutic feeding centres (TFCs) towards more community involvement and community therapeutic care (CTC). To extend this innovation, the next innovative aspect is to empower the women who produce feeding products in the form of "Spirulina chikkies".

If these women received specific **training in nutrition** and basic health care, they could also be involved in national and local nutrition campaigns with these roles:

a) They would produce Spirulina and manufacture such feeding products as chikkies as **their business**. A production centre could be run by women chosen from self-help savings and credit groups; attention should be paid to carefully selecting women with entrepreneurial skills and attitudes. Not everybody is an entrepreneur, and NGOs in particular should be careful to select the most suitable people and not their target groups in the first instance.

b) The same women – maybe supported by other women – could act as **feeding distributors** and run distribution centres or go from house to house to distribute the daily rations to the children and mothers.

c) In order to give these women a special status, they could be **trained as barefoot nutritionists** and act as 'peer' information sources for the mothers. If these women could also act as 'weighing advisors' and be involved in local **weighing campaigns**, they would get even more trust and credibility.

This approach is not completely new: in Bangladesh BRAC has always worked with barefoot nutritionists or health advisors. What is new here is that these women will have food production as their business and this makes their activities much more sustainable than ever before.

The 'place' should also take care of the **commercial marketing** and reach out to the open market. As a rule of thumb, it is estimated that 30% of production should be

sold on the local market with a decent profit. More personal forms of marketing may be more successful than through conventional outlets. For instance, mobile street vendors could sell chikkies during sports events, at cinemas or other public gatherings. Such events could even be used to display some nutrition messages to a broader public and create awareness for the issues of micronutrient deficiencies. These deficiencies are very prominent among the poor, but by far not exclusively present in that group.

### 3.5. P#4: PROMOTION

So far, promotion of Spirulina products has been very limited. By bringing them into mainstream micronutrition initiatives and linking them to other social programmes such as microfinance and self-help groups, promotion will be considerably enhanced. This generic promotion should not only be the task of the women's producer groups but also be clearly made a public health task funded with public resources.

It is important to position the product correctly and not repeat the mistake with which Dr. Wander struggled at the outset, in attributing to the product the image of being for the poor and for the sick.

Ample scope exists for large-scale social marketing campaigns which actively combat malnutrition through important messages. One strategy can be to make the effects of malnutrition more transparent and visible through **weighing campaigns** with regular growth monitoring of children in all villages.

Promotion is very much linked to the 'place' and a good promotion would aim at enhancing the **credibility of feeding women**; this would, from the outset, position the products at a very high level and increase the trust in which the women are held. Associating the feeding women to real growth and weight monitoring campaigns where the mothers (or both parents) can see the progress of their children if they are well-nourished, would achieve two goals at once: it would enhance the parents' awareness and demonstrate the effectiveness of complementary feeding.

A stimulating approach to creating awareness about malnutrition among children themselves consists of operating small production units in schools. If well-managed and every class can produce Spirulina for its daily needs, it should also raise awareness and knowledge of the product. A school project in Hyderabad has introduced such units with great success <sup>26</sup>.

At the same time, it would help a lot to **associate some sports idols** with a promotion campaign. If the local football or cricket club can be convinced to take Spirulina products regularly, it could be an excellent booster for the products, both for the open market as well as for the feeding programs. If some recognised sports idols or movie stars could become promoters and ambassadors against malnutrition, it would position the products much more positively. Imagine if a football star like Pelé would nowadays not only promote Viagra but also Spirulina, just as he did with Ovomaltine more than four decades ago?

### 3.6. MORE Ps: PEOPLE AND POLICY

After the first 4Ps of marketing, here are the fifth and sixth ones:

**People** - as a token of acceptance by the society; and  
**Policy** - as a token of acceptance among governments and institutions dealing with malnutrition.

Whereas 'People' can be addressed by intelligent social marketing campaigns, 'Policy' requires more solid research. The promotion of carrots in Switzerland several decades ago was based on a very strong association between carrots and good eyesight. One of the main motivation campaigns to promote Vitamin A used the slogans "eating carrots makes children beautiful", or "eat carrots and you will get beautiful eyes". Many mothers used to singing nursery rhymes with nutritional messages to their children. Positive images are always stronger than negative ones. It is now compulsory to state "smoking kills" on cigarette packets, yet the impact on smoking prevention is very limited. Positive slogans such as "have you ever kissed a non-smoker?" have been much more effective.

To increase acceptance among **policymakers** calls for more **systematic research**. Whereas nobody questions the effectiveness of eating carrots, the credibility of Spirulina has to be proven all over, seemingly again and again. Some large-scale studies already underway can help provide compelling evidence.

A large-scale trial is in progress in a slum in Mumbai where 1,000 children will be systematically observed in a test during a period of 6 months. Their weight, arm circumference and blood will be analysed systematically. Such research efforts for nutrition projects must be medically sound and socially effective.

Two previous studies undertaken in Madurai by Dr. N Edwin <sup>27</sup> have proven the effectiveness with infants and children: "Most children in the test group showed im-

provement in their general well-being; that was not noticed in the control group". A total of 60 children were selected in Madurai, of which 30 children were taken as test group and 30 were taken as control group. In the test group, children were given Spirulina at a dose of 1gr per day for 6 weeks; in the control group, children were given placebos for 6 weeks. The test has shown statistically significant improvements in almost all indicators, namely haemoglobin, serum proteins, serum total iron and serum ferritin.

Another clinical test in Dakar in Senegal has shown significant improvement in correcting severe malnutrition, with a relatively small sample of 59 children.

It is hoped that the large-scale test in Bombay will give Spirulina the recognition that it deserves in order to be accepted in larger malnutrition programs.



# AND, BY GOLLY, IT REALLY DOES DO YOU GOOD: NUTRITIONAL VALUES

## 4.1. SPIRULINA AS A RICH PROTEIN SOURCE

The protein content of Spirulina varies between 50% and 70% of its dry weight. These levels are quite exceptional, even among micro-organisms. The best sources of vegetable protein achieve only half these levels; for example, soybean flour contains 'only' 35% crude protein. From a qualitative point of view, Spirulina proteins are complete, since all essential amino acids are present, forming 47% of total protein weight.<sup>28</sup>

In this sense, Spirulina is an **excellent source of proteins**, especially as it also ranks high in another important nutritional indicator, the net protein utilisation (NPU). The NPU is estimated between 53% and 61%, which is almost as high as casein. And finally, it ranks very high in the protein efficiency ratio (PER) which is the gain in weight divided by the weight of proteins ingested. This means that the body can make good metabolic use of the amino acids in Spirulina.

What does this mean in practice? Spirulina is clearly not only a good protein source. Just 18 grams of milk or 5 grams of an egg have the same protein content as one gram of Spirulina. Hence those who can afford milk and eggs should not use Spirulina as a protein source. However, eggs, milk and Spirulina are not equally available, so the reality is not so comforting. In the course of researching this book, a poor family in India recounted that they eat eggs only once or twice a month! The reason for this low protein consumption may lay in eating habits (vegetarian tradition) or affordability: even if the family owns two chicken itself, it may be more advantageous to sell the eggs on the market.

The actual protein deficit thus remains a challenge for many people. Spirulina can play a role in reducing the deficit, containing proteins which are complete and very digestible – ideal for mixing with protein-rich cereals:

"The quantity of protein required is about 20 g/day between 6 months and 3 years. As an indication, the mother who gives 800 ml of milk provides her child with just 8 g of protein a day. The weaning pap thus has to supply the child with the missing 12 g of protein.

Ideally, the amino acid composition of these supplementary proteins should be identical to that of breastmilk, i.e. contain the same proportions of the nine essential amino acids (including lysine, threonine and tryptophan).

These amino acids are called essential because the child's organism is incapable of synthesizing them and they have to come from the food. Some proteins of animal origin have an amino acid composition very close to that of breastmilk. These are the proteins in animal milk (cow, goat) and in meat or eggs, which are **generally out of the reach of mothers** in underprivileged settings because they are "expensive" proteins."




## 4.2. SPIRULINA AS A RICH SOURCE OF VITAMINS

Spirulina has a very high **Vitamin A** content, and **one gram** of Spirulina per day covers basically **the entire daily requirement of a person**.

"Each kilogram of dry Spirulina contains between 700 and 1700 mg of Betacarotene and about 100 mg of cryptoxanthin; these two carotenoids are convertible into vitamin A by mammals. "A study on 5,000 Indian children of pre-school age showed that a single daily dose of one gram of Spirulina was surprisingly effective against chronic vitamin A deficiency. After five months, the proportion of children with serious vitamin A deficiency, i.e. presenting with Bitot's spots on the conjunctiva of the eye, fell from 80% to 10%." <sup>29</sup> "Particular emphasis should be placed on a series of studies in the context of the AIDS pandemic; it has shown that the transmission of HIV from an infected mother to her child is strongly dependent on vitamin A deficiency".

Only few other Vitamin A sources are as effective as Spirulina: carrots, as the most common solution, are also very effective, but requires at least one carrot a day, as 50 to 100 grams are needed. A similar amount, 100 to 200 gram of spinach is needed to satisfy daily requirements. It is quite a revolutionary finding is that Spirulina is much cheaper than carrots or spinach as a source of vitamin A. (see comparative table).

It is important to emphasise the absorption capacity of vitamin A on different foods. The vitamin absorption of carrots and spinach in its raw form is much less than in cooked form: apparently, the vitamins are somehow "locked" in the cells of a raw carrot. A study <sup>30</sup> has shown that the vitamin uptake from cooked carrots and spinach is almost 3 times higher than from the raw products. Spirulina has the great advantage that the absorption is very high and its relative value – and cost – is even more favourable than anticipated in the comparative table.

<div data-bbox="129 297 403 436">1 gram of Spirulina</div> 	<div data-bbox="496 297 903 436">= 100 grams of carrots</div> 	<div data-bbox="995 297 1418 436">= 100 grams of spinach</div> 
<b>Cost in India:</b> 0.5-1.0Rs for one gram	<b>Cost in India:</b> 0.7-1.2 Rs for 100 grams	<b>Cost in India:</b> 1.0-2.0 Rs for 100 grams

### Spirulina: a cheap and effective solution

One gram of Spirulina per day can correct malnutrition in a small child in a few weeks. Spirulina can be produced locally in tropical countries and is cheaper than carrots or spinach.

Example of daily requirements of two crucial micro-nutrients. A child's daily requirement (DR) is as follows:

#### Vitamin A:

DR: 700 to 1,000 micrograms per day equal to (in brackets: cost in Indian Rupees(Rs))

- less than 1 g of Spirulina (cost: ~ 0.5 Rs)
- 70 to 100 g of carrots or (cost: ~ 0.7-1.2 Rs)
- 100-200 g of spinach (cost: ~ 1.2-2.0 Rs)

#### Iron:

DR: 5,000 to 6,000 micrograms of iron equal to (in brackets: cost in Indian Rupees (Rs))

- 1 g of iron enriched Spirulina (cost: ~ 0.5 Rs)
- 380-1,200 g of carrots (cost: 5.0- 40.0 Rs)
- 50-200 g of spinach (cost: 0.6- 4.0 Rs)



### Comparison of nutritional values (in micrograms)

Vitamins	1 g Spirulina	100 g carrots	100 g spinach
Carotenoids	3'700	11'000	4'800
Beta-carotene	1'400	1'500	795
Vitamin E	100	465	1'400
Thiamin B1		35	90
Riboflavin B2		40	200
Niacin B5		140	620
Vitamin B6	8	270	220
Vitamin B12		3	55
Inositol			640
Folic Acid	0	25	145
Biotin B7 or H	0	5	7
Panthothenic acid B	3	1	270, 250
Vitamin K	22	15	305
Vitamin C		700	50
<b>Minerals</b>			
Calcium	10'000	35'000	115'000
Phosphorus	8'000	35'000	45'000
Magnesium	4'000	13'000	60'000
Iron	1800-6000	385	3'800
Zinc	300	50	600
Copper	12	50	95
Manganese	50	175	645
Chromium	3	4	9
*(iron enriched spirulina)			

Spirulina does not contain as much vitamin B, except for the very important **vitamin B12**, which is by far the most difficult to obtain in a meatless diet since no common plant food contains it. Spirulina is four times as rich in B12 compounds as raw liver, long put forward as the best source. However, there is still a debate going on whether the B12 vitamin of Spirulina can be absorbed by the body.

### 4.3. IRON, ZINC AND OTHER MICRONUTRIENTS

With respect to minerals, Spirulina is of particular interest in iron, calcium, phosphorus and potassium. The very high iron content should be doubly stressed because iron deficiencies are widespread, particularly in pregnant women and children, and good sources are rare. As anaemia is one of the most prevalent chronic forms of malnutrition – especially among pregnant and lactating women and thus their children – Spirulina can really play a major role in combatting iron deficiency. It is indeed very easy to enrich Spirulina with iron by 'fertilising' the Spirulina ponds with iron so that the algae absorb them. This is a kind of bio-fortification method as well.

In terms of money, iron-enriched Spirulina is a very effective source of combatting iron deficiency: Spirulina is much cheaper than carrots and spinach for necessary iron intakes. Very few alternatives are suitable to provide substantial amounts of iron.

The natural content of zinc is not very high in Spirulina. It is possible, however, to enrich the Spirulina algae by adding zinc into the tank basin, and thus produce "zinc-enriched" Spirulina. Zinc is a trace element which has recently reached the top of the agenda in the fight against diarrhoea-related diseases. Presently, Antenna Technologies is testing the zinc enrichment of Spirulina in its test production plant and field tests can be expected in the near future.

### 4.4. WHAT SPIRULINA CANNOT DO: COMBATTING IODINE AND FOLIC ACID DEFICIENCY

Spirulina offers no solution to folic acid or iodine deficiency.

The problem of folic acid deficiency is a very specialised one which affects some 200,000 children with severe birth defects every year. This is of course a tragedy, but less important in numbers than the impacts of vitamin A and iron deficiencies.

With respect to iodine, salt fortification is probably the best option and is implemented on a relatively widespread basis.



It is crucial to inform doctors and medical personnel. This promotion can then also create awareness amongst mothers



Many mothers are themselves suffering from anaemia. When they come to the hospital, it is often 'just in time' for their children



If mothers' needs are addressed early their children's suffering from anemia and vitamin A deficiency could be avoided



Promotion also means informing students and teachers about malnutrition. Healthy children can also study much better



Parents are very happy that their children receive a chikki at Prem School in Tiruppur



Micro-nutrient deficiency seriously affects the cognitive development of children. This girl has great difficulties in concentrating. Spirulina could have prevented this

# SPIRULINA IN AFRICA: COMBATTING MALNUTRITION AND EASING LIVES OF HIV/AIDS VICTIMS

# 5

## 5.1. THE STATE OF AFFAIRS OF SPIRULINA IN AFRICA

It is in Africa that Spirulina has grown naturally for many centuries, in the Lake Chad area, and has been a well-known product both for home consumption and for export.

In Senegal, more recently, Antenna Technology has been cooperating with Éducation et Santé, a large NGO whose president is Madame Viviane Wade, the wife of the country's President, and herself a nutritionist by profession. Informed sources report that, on the recommendation of his wife, the Honourable President is regularly getting Spirulina on his breakfast table and is apparently eating it with pleasure.

Important projects are also going on in Burkina Faso, Mali and Niger, where Antenna Technology is working with local partners, NGOs, health centres, hospitals and villages.

In Burkina alone, five sites are presently producing Spirulina and a producers' group is being organised. One of the largest projects is in Loumbila, a small town located 15 kms north of the nation's capital, Ouagadougou. The Loumbila centre is run by the 'Congrégation des Travailleuses Missionnaires' where Spirulina production started in 2000. In the near future, it will count 730 m<sup>2</sup> of basins capable of producing 5 kg a day or more than 1.5 tons of dry Spirulina a year, enough to feed 2,000 to 3,000 children. Production costs in Africa are considerably higher than in India, amounting to at least US\$ 10 US per kilogram. There is still room for an optimisation process on production patterns in order to reduce costs as much as possible. Most of the present installations are linked to charitable organisations and this is seen as a severe limitation to the establishment of an economically viable production system.

An excellent documentary film by the European cultural channel ARTE broadcast in May 2005 showed the impact of Spirulina in Burkina Faso and hinted at its incredible potential in the future. Important organisations involved in malnutrition, most notably Helen Keller International, are interested in promoting Spirulina as an alternative source of feeding and as a tool to combat malnutrition in West Africa. The need remains for a large scaling-up initiative.

## 5.2. IMPROVED QUALITY OF LIFE FOR HIV/AIDS-AFFECTED PEOPLE

Zacharie Kasongo from the Democratic Republic of Congo was a post-graduate student in Geneva. He worked first as a volunteer and now as a representative of Antenna Technology in Goma in the Great Lake Region, near the border between DRC, Rwanda and Burundi. He introduced several Spirulina production tanks (see photos), mainly serving orphanages and feeding centres. He soon realised that HIV/AIDS-affected people were demanding Spirulina. Not that Spirulina could cure the disease, but obviously it could help the patients feel much better, and if HIV/AIDS-affected people are anaemic, suffer from diarrhoea or micronutrient deficiency, their immune system will be further weakened.

There are also indications that Spirulina can positively influence the disease, but much more research is needed to prove this. What seems to be very clear is that Spirulina helps HIV/AIDS-affected people in their daily life – it reduces their pain and strengthens their immune systems so that they can work and have a better life.

Pending any scientific evidence, we have taken some 'testimonies' received by Zacharie Kasongo from a group of HIV/AIDS-affected women, men and They are summarised in the captions to the photos nearby. The full testimonies have been signed and sent to donor agencies as a plea to continue the provision and to encourage the scaling-up of local Spirulina production.

## 5.3. RE-THINKING FOOD AID TO FIGHT HIV/AIDS

That the HIV/AIDS pandemic is a massive challenge to conventional food aid approaches has been underlined by the recommendation of the International Food Policy Research Institute (IFPRI) to review the traditional systems by applying "an HIV/AIDS lens" <sup>31</sup> to the present systems in place. "We know that food and nutrition are fundamentally intertwined with HIV transmission and the impacts of AIDS. Evidence of the ways in which food insecurity and malnutrition may increase susceptibility to HIV as well as vulnerability to AIDS impacts, and how HIV/AIDS in turn exacerbates these conditions is increasingly well documented." <sup>32</sup>





Nzigere, 29, was raped during the war and made pregnant. She was like a skeleton before coming to the centre. Yalale Kalume, 38, was one of a rich custom's officer several wives. Now, she takes 2 grams daily and can work again



Rose, 57, had given up eating; she weighed only 40 kg and her belly was inflated. Since taking Spirulina, she has gained 10 kg



Annie, 43, is a widow and looks after 11 children since her husband died of AIDS; she is not HIV positive herself but is grateful to use Spirulina for feeding her children





Sisters in Goma, Democratic Republic of Congo, tasting Spirulina from a recently built tank



Children in an orphanage in Goma (Congo); some lost their parents in the war, some through AIDS



The congregation of missionary workers in Loumbila (Burkina Faso) runs a production unit with over 300m<sup>2</sup> of round-ended tanks



The sisters run an orphanage in Loumbila, 15 kms north of Ouagadougou. They plan to scale up annual production to 1.5 tons



This production centre at Ouahibuya (Burkina Faso) has basins of 100m<sup>2</sup> and serves a rehabilitation and nutrition centre



Although, production costs are double those of India, Spirulina is highly appreciated in malnutrition centres in Africa

In general, IFPRI argues, the **need to refocus food-aid**, and to adjust practices regarding micronutrients (in which Spirulina could play a key role), should address the following issues:

**a)** Food aid needs to be better targeted to reach the really poor HIV/AIDS victims. For instance, the conventional food aid concept is based on the hypothesis that labour is abundant and that food-for-work is self-targeting". However, HIV/AIDS-affected women and men are not capable of working hard any more;

**b)** The number of vulnerable groups is increasing drastically and thus the requirements for large-scale complementary feeding programmes will significantly rise. More than ever before, cost-effective and sustainable solutions will become crucial. On the other hand, IFPRI says, "adequate nutrition can thus prolong economically active life and contribute to their 'positive living', enabling them to pass on important skills and knowledge to their children, plan for their children's future, prepare their children psychologically and delay their orphanhood."

**c)** Especially the prevention of mother-child transmission is crucial: research shows that malnutrition increases the risk of transmission and pregnant and lactating mothers will need special support with micronutrients as well as their children.

**d)** One of the most disturbing long-term consequences of the AIDS pandemic is the growing number of orphans. There are increasing numbers of child-headed households. To find solutions to the growing number of orphans and vulnerable children and to meet their micro-nutritional needs is another important challenge.

Local Spirulina production and its use in targeted feeding programmes for HIV/AIDS-affected people present innovative ways to find sustainable and cost-effective solutions to alleviate the disastrous effects of the AIDS pandemic in Africa and elsewhere.



# TOWARDS A NEW BUSINESS MODEL FOR SPIRULINA IN DEFEATING MALNUTRITION

6

We have a dream. It is for Spirulina to take its place in the short list of viable, lasting solutions to the unviable, too-enduring afflictions of malnutrition.

Can it come true and is it feasible, this dream of ours? How can we speed up the day when sustainable businesses will have contributed to the removal of malnutrition – for as long as is needed?

Towards the end of 2005, we moved from our early, enthusiastic calculations, to a more founded feasibility study to establish the sound financial scenarios in which Spirulina works: where it works, not only for the consuming body and brain, but for everyone involved all along the Spirulina supply chain, from producer, through wholesaler and retailer, to the needy consumer. From tank to tongue.

## 6.1. THE COST ADVANTAGES AND DISADVANTAGES OF SPIRULINA

Local Spirulina production with village women, making chikkies and feeding malnourished children through such decentralised organisations is not cheaper than industrial food fortification. It would be clearly cheaper to just add some artificial vitamins and minerals to a staple food.

The advantages of local production carry aspects which, it may be argued, are also clear disadvantages. Much work is involved in the effort involved in building up viable local production units and training the 'owners' or operators of these units in the technology and management of small units. Similarly, the broad set of approaches required – from the marketing of Spirulina products on the open market to the training of women as barefoot nutritionists and involving them in feeding programmes – adds extra dimensions which are less of a concern in classical feeding schemes.

## 6.2. MAKING 'BUSINESS BIG' – IS SCALING UP WITH 40 MADURAI CENTRES A DREAM?

We set the scale of the 'dream' thus: a scaling-up plan to establish a larger but decentralised production base with some 40 centres comprising a joint production capacity of at least 50 tons per year, and allowing the feeding of at least 100,000 malnourished children on a sustainable basis.

Following a feasibility study, we are now aiming at establishing 10 clusters, or nodes, of 40 production units in all, with a total production of 60 tons.

Feeding cost per category	Infants (1g spi/day) plus cereal and jaggery	Children (2g spi) plus cereal and jaggery	Pregnant and lactating mothers (4g spi) plus cereal and jaggery
Cost of Spirulina alone (Indian Rupees)	9 Rs. per month	18 Rs. per month	36 Rs. per month
Cost of millet, jaggery	10 Rs. per month	10 Rs. per month	10 Rs. per month
Cost of distribution	2 Rs. per month	2 Rs. per month	2 Rs. per month
Total cost per category	21 Rs. per month	30 Rs. per month	48 Rs. per month
/ . parents' contribution (10 Rs. per month/family, average)	/ . 5 Rs. per month	/ . 5 Rs. per month	/ . 5 Rs. per month
	16 Rs. per month	25 Rs. per month	43 Rs. per month
Total cost per category	€ 0.26 (US\$ 0.35) per month	€ 0.42 (US\$ 0.55) per month	€ 0.72 (US\$ 0.95) per month
Equivalent in € and US\$	€ 3.12 (US\$ 4.20) per year	€ 5.00 (US\$ 6.70) per year	€ 8.60 (US\$ 11.40) per year

### Feeding cost with local Spirulina production units

However, local decentralised production by village women and enabling them to become involved in feeding programmes as barefoot nutritionists has some important advantages in terms of local ownership, the potential of awareness creation and for long-term sustainability.

### Key elements of a feasibility study

We see three distinct segments in the market to which the production units should cater:

**The market of the rural poor directly**, to be addressed by setting up supply chains with village kiosks run by

women from Self-Help Groups (SHG) and selling affordable products for children and mothers. We envisage a direct market for children, with products priced at 50 paise, the usual pocket money of poor rural children. To cater to this market is a challenge requiring top efficiency in supply chain management and wafer-thin production margins in order to allow a hefty margin for the kiosk woman. The other product envisaged is a monthly 'subscription' where a family pays between 10 and 20 Rs. per month to feed one or more children daily.

**The institutional 'feeding market'** consisting of NGO feeding programmes, mid-day meals, and of feeding programmes in schools such as the Prem Schools in Tiruppur, supported by the Corporate Social Responsibility (CSR) programme of the Swiss company Switcher SA. This market is huge and Spirulina is cost-effective: it is possible to deliver a good feeding product for around 2 Rs. per child per day, adding up to less than US\$ 10 per year. However, to use Spirulina chikkies in any of the State mid-day meal programmes would require quantities of at least a factor 10 to 20 times larger than the few dozen centres envisaged here.

**The open 'wellness' market of up-market health-conscious customers** serving to make the operation more profitable and allow a cross-subsidisation of the rural market. Tapping this market with suitable marketing strategies has already been tried and should yield good results. Three market segments have already been identified:

**a)** health clubs, gyms and body builders with tablets; **b)** diabetic patients with tablets and capsules and **c)** joggers and morning walkers through a sales cart with fresh Spirulina lime juice. Also under consideration is a partnership with a large food processing company in Europe, launching a Spirulina biscuit that would include a small 'fee' for cross-subsidies of feeding programmes. It could be advertised, for example, with the slogan: "take one... and help feed a malnourished child."

The feasibility study was completed in April 2006. It comprised a study of the production systems, an experimental product development process, a consumer preference study and a market assessment for supply chain analyses in different markets. It concluded that the 'dream' is indeed feasible, technically and financially.

The greatest task, also thoroughly achievable, is to meet the organisational challenges implicit in decentralised production, in applying common practices and in concerted marketing. A scaling-up plan with decentralised units will require solid team- and capacity-building efforts, as all partners need to agree to the disciplines of partnership and on matching rigid quality standards.

## 6.2.2. INSTITUTIONAL SETUP: NGOS AND A MARKETING COMPANY

To produce and market Spirulina in a financially sustainable way and making it available to combat malnutrition is much like a walk on a tightrope. The systematic and solid institutional support required for running 40 decentralised units is more complicated than operating one industrial plant. Yet this approach of fragmented production offers great opportunities and rewards, and it allows local problems to be solved locally.

After examining the perennial issue of who should control and operate the units – private enterprise, or NGO operators, drawn either from partners of Child Fund India or other NGOs – we adopted the model where the core unit in a node would be NGO driven. The three compelling reasons were the high level of motivation; the reduced, or even minimal, risk of shifting the focus (a process known as 'deviation') to high-yield markets at the expense of the poor; and the ability to create and sustain a social brand to serve the up-scale market segment.

**There are five organisational challenges to be met:**

**Capacity building:** Some 15 NGOs have already indicated their great interest in pilot efforts at production and marketing, during a workshop held in Bangalore in March 2006. Most of these NGOs are partners of Child Fund India, the second largest child development organisation in India. Each organisation is already supporting at least 1,000 children; some are involved in feeding programmes with over 10,000 children. They have all expressed a need for training, marketing and financial support.

The existing competence centres in Madurai, Kolar and Auroville could be at the core of providing capacity building support. These centres in turn would be backed up by a strong and efficient centralised coordination cell with a capacity to provide technical and marketing support.

**Marketing and quality control:** This cell could, at a later stage, grow into an independent 'Spirulina Market Development Company' (SMDC), owned by Child Fund India, Antenna, other social investors and the key stakeholders. An initial calculation has shown a fair profitability for such a company and a good potential to generate income for cross-subsidisation. Quality control mechanisms are already in place on a small scale but for scaling-up strict quality standards should be formulated, and product brands should be established. All customers – especially the poor with their investment of 50 paise – deserve a high quality product which they like and know makes them healthier. Each production unit needs an appropriate laboratory for on-site quality control, backed up by

laboratories for more substantial quality tests at the competence centres. There can be no compromise on these quality standards. Product imitation by other producers can be prevented by emphasising the 'unique sales propositions' (USPs) in product design and branding which are hard, or impossible, to copy.

One early analysis has shown that the Child Fund India constituency could give credibility to product quality and also include an ethical or 'fair trade' dimension which the private sector cannot. One USP could be to reserve Rs. 2 from the sales price for a cup of 'jogger's drink' (market price: 10Rs. per cup) for cross-subsidisation of feeding efforts. One Child Fund India slogan for fund-raising is "save a drink and feed a child". This could be inverted into: "drink a cup and feed a child".

After the establishment of the SMDC, there will still be a need for a capacity building and coordination unit to support the decentralised production units with training and technical assistance.

**Production process:** The scaling-up model is based on the notion of an interested NGO partner of Child Fund India operating one production unit themselves as a 'node' with 36 tanks, and gradually assisting three other units to join a cluster of four units. A firm but modest growth cycle for a node could be to establish between 2 and 6 tanks in the first year of operation, expand gradually during the second year to 20 tanks, and continue to 36 tanks by the end of the third year. Refinements in productivity will boost output further, reaching a maximum level at the end of the fourth year.

Once a node has mastered technology and management issues, say during their third year of operation, they could gradually bring 'satellite' production units of a similar scale online, supporting them in their own four-year growth cycle. The model assumes the start-up of one satellite per year, typically operated by a NGO, smaller family units, medium-scale enterprise units and bigger units run by groups of Self-Help Groups (SHGs). Over 1,000 SHGs could be linked in the process and play a role in rural marketing of Spirulina products. The 'nodes' would then serve as collection centres – quite similar to the milk collection centres – where the quality is checked and the producers get regularly paid.

**Micro-production units in schools** could be established as well, and thus create awareness among the children themselves about Spirulina as a means to combat malnutrition. Child Fund India partners already run more than 1,500 schools and nurseries. A school with small tanks of 4-5 m<sup>2</sup> could produce enough for a daily glass of Spirulina lime juice in each class. This measure could also

open the market for rural supply chains, as children would know why they should ask for a Spirulina chikki when spending their pocket money. Quality issues would need to be addressed.

**Product development:** A range of products has been developed for different markets: tablets and capsules can be made by local pharmaceutical industries.

Whereas most tablets contain only 500 mg of Spirulina, the larger tablet (right) contains 750 mg. Pregnant mothers can thus take fewer tablets to get the recommended dose of 3 to 4 grams per day.

### 6.2.3. ORGANISING FOR THE MARKET PLACE BY CREATING A MARKET DEVELOPMENT COMPANY

The market of Spirulina is quite a specialised one. While no comprehensive data on sales could be obtained to assess the market size, it appears that Spirulina is marketed, with high margins, to specific target groups and only through pharmacies. To promote Spirulina as a food supplement will require a considerable effort in market development in all the three markets envisaged – but not without social and financial rewards.

Clearly the decentralised units will require support in market development, marketing and market differentiation and demarcation. An apex-style market development and marketing company could serve as the heart of decentralised production and serve as an agent to develop the markets; assure quality and branding; and ensure logistics, packaging and transport. In so doing, the company could become a very profitable enterprise, achieving its social objective in a sustainable way.

It is therefore proposed to create a professionally-run 'Spirulina Market Development Company' (SMDC) as a separate, for-profit company. The shares for such a company could be held by development agencies such as Child Fund India, Antenna Geneva and other philanthropic investors. The feasibility study indicated that such a company would need a share capital of US\$ 150,000, could become profitable already in its third year and achieve annual profits of up to US\$ 200,000 after six years.

### 6.2.4. ECONOMIC VIABILITY AND PRODUCTION COSTS

An important element in the cost structure of a production unit are the prevailing local conditions – in terms of climate and infrastructure. The climate – rainfall and solar radiation – defines the productive 'season'. Normally, production is possible for ten months in tropical areas; further



This woman runs a village kiosk and sells cookies, candies and sweets for 50 paise to the children; for their pocket money



"Namkeen" a popular spicy snack with dried strands of Spirulina



A range of products for different markets: tablets and capsules can be made by local pharmaceutical industries



Most tablets contain 500mg of Spirulina; the tablet to the right contains 750mg. Pregnant mothers need to take less tablets to get the recommended dose of 3 to 4 grams per day



Every morning this lady sells health juices and soups to joggers. She starts at 5.30 in the morning and stops at 10 when all the drinks are sold. She finances a centre for widows with these sales



North, seasonal production is still possible for 6 to 8 months. The availability of land, and access to water, can greatly influence the investment cost, and thus the level of amortisation. The main recurrent costs are labour and nutrients (fertiliser). Given these variables, it is not possible to project the production costs very accurately and one needs therefore to allow for a certain bandwidth.

In the following calculation, we assume an investment cost of Rs. 1,000,000 (US\$ 22,220) for a production unit with 36 tanks of 18 m<sup>2</sup> – a total surface of 648 m<sup>2</sup> with an annual production capacity of just above 1,500 kg of Spirulina – 1,555 kg to be precise. If the production unit has enough land already and a water source, then the investment cost can be considerably lower.

**The production cost for such a unit would be as follows:**

Production per year: average of 150 kilograms during 10 months = 1,500 kg per annum	In Indian Rupees	In US\$ (45 Rs. = US\$ 1)
Salaries (25,000 Rs/month for 10 women, incl. supervisor and social costs)	300,000 Rs	US\$ 6,670
Nutrient (65 Rs/kg)	100,000 Rs	US\$ 2,230
Administration	24,000 Rs	US\$ 540
Amortisation and interest on investment of Rs 1,000,000 over four years	250,000 Rs	US\$ 5,560
<b>Total cost per annum</b>	<b>674,000 Rs</b>	<b>US\$ 15,000</b>
<b>Total cost per kilogram (ex-factory)</b>	<b>450 Rs/kg</b>	<b>US\$ 10</b>

For a unit with lower investment and amortisation costs, production costs are significantly lower. If investment costs were Rs. 100,000 instead of Rs. 250,000, then production costs are Rs. 350 per kilogram.

Since these reduced levels of investment are realistic scenarios for some production units, then the production cost of Spirulina ranges between US\$ 7.75 and US\$ 10 per kilogram (350 to 450 Rupees). Anecdotes are not always reliable indicators in the precise art of economics, but in this case, this price range is, more or less, a realistic rule of thumb. As Hendrik Jan from Auroville said: "If you pay people 400 Rupees per kg they will not produce. And if you pay 500 Rupees, they will produce Spirulina for you."

On this basis, there is a very positive answer to the key business question: 'Can we service our investment?' The variable production costs per kilogram of Spirulina (labour, inputs and administration) can be as low as 275 Rupees. Let us settle on 300 Rupees (US\$ 6.66). With an ex-factory sales price of 450 Rupees, some US\$ 3 can be used for servicing the investment.

This price range will allow our product, with its assured quality and local supply, to be very competitive. Low-grade Spirulina is available on the world market from China at similar prices and is even available from the major Indian industrial production units (Parry and Dabur, who sell principally to Western markets) starting at 350 Rupees for low quality.

## 6.2.5. PRODUCTION SETUPS AND INVESTMENT COSTS

The feasibility study suggests a model of operating medium-sized units run by NGOs and/or advanced SHGs with an entrepreneurial track record. It considers that the optimal size of a production unit is about 650 m<sup>2</sup> (or

36 tanks of standard 18 m<sup>2</sup> each). The production capacity of such a unit would reach 1,500 kg of Spirulina per annum, once it has reached the maturity of full-fledged production in the fourth year.

To establish a unit of this size, the initial investment would be between Rs. 1 million (US\$ 22,220) and Rs. 1.2 million (US\$ 26,660) as follows:

### Investments per unit:

Tanks 36 x 18 m <sup>2</sup> @ Rs 15,000	Rs 540,000
Drying Unit	Rs 100,000
Bore well (Water Source)	Rs 100,000
Tools and small lab	Rs 60,000
Training and Tech support (first year)	Rs 60,000
Working Capital (first year)	Rs 90,000
Local marketing support (first year)	Rs 50,000
Land and buildings (if not available)	Rs. 200,000
<b>Total investment costs (land and buildings available – or to be acquired)</b>	<b>Rs 1,000,000- Rs 1,200,000</b>

### 6.2.6. INVESTMENTS AND RETURNS FOR A SCALING-UP PROGRAMME

Most of the key parameters of the financial plan are fairly well identified, while they will need to be refined at a later stage with detailed planning figures. Recalling data introduced above, the following costs, returns and investments are projected:

**Production units:** we estimate that 10 partner NGOs of Child Fund India will become seriously involved in production. Each partner will setup one node as a production cluster with one unit run by the NGO itself and 3 satellite units to be run by Self-Help Groups, other NGOs or private farm families. Each unit will start with 2-6 tanks in the first year, 20 tanks in the second and 36 tanks in the third year. The establishment of the 4 units will be staggered.

The investment of one unit is estimated to be between 1 and 1.2 million rupees (US\$ 22,220 to US\$ 26,660). The node will also need to invest in a laboratory to serve all four units. Depending on the availability of land, the total investment of one node is thus, very approximately, between 4.5 and 6 million Rupees or US\$ 100,000 to 150,000.

Each unit will produce gradually starting with only 66 kg in the first year and increasing up to 1,555 kg of Spirulina in its fourth year. One node will therefore unfold its total production after the 6th year with 6,220 kg per annum. If the production can be sold at roughly US\$ 10 ex-factory, the entire investment may be repaid in 4 or 5 years; the variable production cost is less than US\$ 7 per kg which allows up to US\$ 3 per kg to be used for servicing the investment.

Since the units will start to repay their investments in the third year of operation, allowing funds to be re-invested quickly, the overall production units with 10 nodes, totaling 40 units, can be financed with an investment fund of roughly US\$ 1 million. It is planned to raise part of this fund from philanthropy investors.

The Spirulina Market Development Company (SMDC) should invest its profits mainly in market development and to develop intelligent marketing setups in the up-market segment and in areas of social marketing. The company would require an investment fund of some US\$ 150,000 for working capital and start-up operations but will be profitable from its third year onwards.

The capacity building and coordination unit, needed to support the decentralised production units with training, technical assistance and coordination, should be located at Child Fund India. It will require an annual budget

of US\$ 100,000 to US\$ 150,000. This should be financed with grant money, as this is a public contribution.

Feeding programmes and marketing. The planned total production of 60 tons at full capacity will be sold in three equal parts in the three market segments being targeted. The 40 tons available for direct or institutional feeding programmes can cover around 140,000 children. If the investment fund is used for further expansion after the nodes have repaid their original investments, production can expand and reach up to 250,000 children. Cross-subsidies are needed to finance some of the feeding programmes, especially the direct marketing to the rural poor, and this is possible through guaranteeing the purchase of 2/3 of the production through the SMDC.

For the time being, it is not planned to link up with mid-day meal programmes of the Governments, mainly for two reasons:

- a) the volumes of Government feeding programmes are much larger (in Tamil Nadu alone, the Government is feeding over 8 million children) and
- b) it is not yet possible to guarantee the quality for such large volumes and it is difficult to avoid corruption in such large programmes.

**To summarise:** Ten partner NGOs of Child Fund India could set up 10 clustered production nodes with 40 production units with a production capacity of 60 tons of Spirulina. This setup is a public-private venture and combines private initiative (production and marketing) with public support (capacity building and awareness creation). There are three requirements:

**An investment fund of US\$ 1 million** to finance the investment of the 10 nodes; this fund may be raised from private social investors or companies with a CSR motivation. It can also be raised in portions of US\$ 50,000 to US\$ 100,000 (e.g. investment for one node);

**A Spirulina Market Development Company (SMDC)** with a professional marketing team to cater to the private up-market segment and the institutional private (NGO supported) feeding market with start-up investment capital of some US\$ 150,000;

**A Capacity building unit** to be funded with grant money of roughly US\$ 1 million spread over 6 to 7 years as a public contribution to set up decentralised village units;

The total private investment (1 + 2) is thus US\$ 1.15 million and the public contribution is roughly US\$ 1 million over a period of 5 to 7 years with the aim of creating a sustainable structure to defeat the malnutrition of up to 250,000 children.



### **6.3. FROM THERE TO MASSIVE SCALE: SPIRULINA TANKS INSTEAD OF COWS?**

Once the markets are established and the marketing company is running at full capacity, one could imagine that hundreds and thousands of Self-Help Groups would adopt a similar model of decentralised production. Instead of having a cow or two, a family could have one or two Spirulina tanks and grow the algae slurry. This would only be possible if SHGs would take the activity up in a very organised way and if there would be support and collection centres quite similar to the milk collection centres which AMUL installed all over the country under the famous 'Operation Flood'.

It is also envisaged to talk to major food processing industries in order to get them interested in making a biscuit or another product with Spirulina as a food complement for common consumers in India, but mainly as a product for large scale feeding programmes in order to end the shameful prevalence of widespread malnutrition in India.

This may sound like a vision still far from reality: however, there are established schemes under Child Fund India that families have a cow or two that generates them a regular income. It may be realistic that the NGO nodes proposed under the scaling-up scheme would set up such collection centres in control of the required quality. Just as with milk collection, it will be required that each supplier's quality is tested at the collection centre, and if not, then corrective measures should be implemented.

With that, and an assured market, then hundreds, thousands and more of Self-Help Groups could go into business and produce Spirulina both as an income generation activity as also as a tool to fight malnutrition.

Working capital would mainly comprise fertiliser costs and wages (or salaries of employees). The cost per kg of Spirulina (dry weight) produced would be about Rs. 400, comprising of wages (Rs. 150), fertilisers (Rs. 100), running cost (Rs. 75) and depreciation (Rs. 75). This cost would be 2-3 times higher in the first year because of the learning phase.



# OTHER BUSINESS-ORIENTED APPROACHES TO COMBATTING MALNUTRITION

7

## 7.1. MILK IN SO! MANY WAYS: HAGAR SOYA, CAMBODIA

Hagar Soya Company Limited (HSL) is Cambodia's first large-scale soya milk producer, and also the first to use ultra-high temperature processing (UHT) technology and Tetra Pak aseptic packaging. Both give HSL's brand, "So! Soya", a long shelf life, with no requirements for refrigeration. These aspects are essential for nationwide distribution and exports in hot countries with little cold storage. The HSL Company has a gleaming new factory in a suburb of the capital, Phnom Penh, with an innovative investment of US\$ 1.2 million.

Hagar is a Swiss NGO that helps abused and abandoned women and children to rebuild their lives. Since 1994, Hagar has helped some 100,000 people through a range of services: a shelter and foster homes, farming communities and rural schools, installation of water filters, counselling, literacy classes, health education and small business development. In 1998, it began producing soya milk to sell to NGOs, schools and the public, and to give the residents of its shelter an opportunity to learn jobs skills and earn an income. Within one year, Hagar was making a profit from sales throughout Phnom Penh, but it could not market beyond the capital because that required refrigeration and had a shelf life of only a few days.

Funding for the new plant was obtained from the Mekong Private Sector Development Facility which specialises in small enterprise promotion in the Mekong region, and expanded by private equity finance of US\$ 450,000 from the International Finance Corporation, the private sector arm of the World Bank Group. This enabled Hagar to scale up the operation from a micro-enterprise with 10 employees and a capacity of 500 litres a day, to a large factory with 40 employees and the capacity to produce 12,000 litres daily.

Besides selling on the open market, HSL aims to establish a large school-feeding pilot programme in order to:

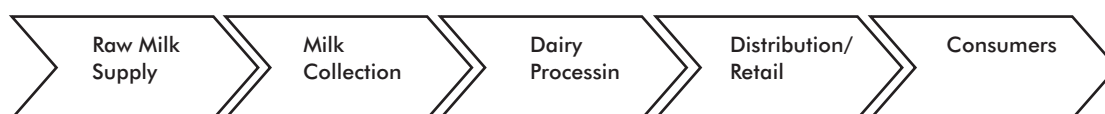
- Boost the health of poor and malnourished children
- Provide an easy route for addressing micronutrient deficiencies

- Increase school attendance rates, especially among young girls
- Improve the effectiveness of education through higher ability to concentrate
- Educate children about the importance of nutrition and hygiene.

Being a pilot programme, it is not yet known what the costs for this programme will be in the long run. Preliminary information indicates that one daily ration for a school child is in the order of €0.12. This does not include the costs of transport logistics, monitoring and evaluation. While this is still a very economical option, it is clearly much more expensive than the local production and processing of Spirulina chikkies, although the products can not and should not be directly compared. Whereas HSL is a medium or large-scale industrial operation, Spirulina production can be a very local setup which has its advantages in its decentralised operation. It may be much cheaper to set up a centralised industrial plant with higher operating costs, whereas the decentralised units have lower operating costs but need more effort in terms of capacity building.

The HSL is a business approach to malnutrition at quite another level of technology, but it has the same goals and objectives. Given the higher level of technology, such approaches can only be realised through a strong collaboration with the private sector in the form of public-private partnerships (PPPs). The Swedish-Swiss Tetra Laval Company is promoting such approaches in many countries and seeking collaboration with development agencies. A feasibility study was made by UNIDO for a dairy processing plant in Burkina Faso<sup>37</sup>, where Tetra Laval would co-invest in a dairy processing plant and provide technical assistance in all five elements of the value chain (see diagram). UHT technology is proposed in order to reach out to rural areas and small towns without the need for refrigeration; it is obvious that setting up a cold-storage chain is out of question.

Cooperation with development agencies is sought in two areas of the value chain:





The "core" of the plant is this modern tetra pak packaging machine



The packaging and dispatching zone



The factory provides jobs for women and men graduating from Hagar's rehabilitation and prevention programmes



The factory is an up-to-date modern processing plant using UHT (ultra high temperature) processing so that the soy milk does not need cooling



Hagar soy project produces soy milk in tetra pak for school feeding programmes and for the open market ([www.hagarproject.org](http://www.hagarproject.org))

It is almost impossible for a dairy industry to collect enough milk – or soybean – from small farmers at an early stage of operation, and it may take years to set up a milk or soybean collection system. This is indeed a task for development agencies, as many small farmers will benefit from a processing industry; on the other hand, the markets for dairy products are also limited. To launch school feeding programmes has a double purpose: it is

a good thing to do in its own right, because it improves nutrition and school attendance. On the other hand, it is also a good strategy to create a market for dairy products, and this is again a pre-requisite for a viable local dairy industry.

One may now ask if markets for dairy products should be created with public money? Is this really a development

#### **The real school milk issue (excerpt from SIDA study):**

Are school milk programs good development projects or not? The answer is that they are – not only because milk is a superior food product but, more importantly, because the alternative – commercially promoted carbonated drinks – have no nutritional value at all.

The true issue is not animal protein and vitamins versus vegetarian proteins and vitamins. Nor is it whether scarce land should be used to produce fodder for animals or food for humans. It is milk versus Coca Cola! More and more poor children grow up in urban environments where carbonated drinks are easily available and heavily promoted. They are cheaper and more readily

available but infinitely inferior as nutrients.

Milk is more than a drink. It is both a drink and a food product. As a drink it competes with mainly carbonated drinks and, unless it is credited for its superior food qualities, it does so at a disadvantage. Milk is more expensive and milk has a limited shelf life although UHT technology has improved the latter. The biggest increases in consumption of carbonated drinks have been in the former communist countries and in Asia and it is the younger generations, school children in particular, that are the main consumers. In some regions, such as Eastern Europe and Central Asia, carbonated drink sales have been marred by a decline in milk consumption.







In Zimbabwe, IDE (International Development Enterprises), promotes small drip irrigation kits for growing vegetables



These drip irrigation systems reduce the strenuous work of watering and weeding and allows gardening for HIV/AIDS-affected persons



A balanced diet and sufficient intake of micro-nutrients can not cure the disease but it does makes life easier for HIV/AIDS victims



task? A first answer to this question can be given with the example of 'Operation Flood' in India, where the renowned 'Anand' national cooperative dairy industry was established in the 1960s by the famous Dr. Kurien – 'the milkman from Anand' – with the support of the World Bank. It is, today, still the largest rural development project ever undertaken in the world, with almost 10 million farmers as members of more than 170 milk producers' unions.<sup>38</sup>

There is another strong argument in favour of promoting dairy projects – as private or cooperative ventures – through the support of development agencies: the alternative to school milk is Coca Cola! The Swedish SIDA undertook a critical study: "Should SIDA support Dairy Projects" <sup>39</sup> and came to the conclusion that is more than justified to do so.

School feeding programmes have become mainstream programmes of the World Food Programme (WFP) because of their potential to solve several problems at once: improve nutrition, increase school attendance and improve students' ability to concentrate. If they can be implemented in a sustainable way by involving local enterprises, they have an additional important development impact.

## **7.2. IDE'S HORTICULTURE PROGRAMME FOR HIV/AIDS VICTIMS IN ZIMBABWE**

Finally, it is useful to mention a new approach in southern Africa which merges humanitarian aid with development objectives. The project consists of empowering some 12,000 vulnerable households with a package of seeds, knowledge and a drip irrigation kit in order to improve their food security, health and nutritional status. This project is implemented by International Development Enterprises (IDE), an international NGO specialised in market-based approaches to development.

With widespread hunger following failed harvests, in Southern Africa, and especially in Zimbabwe, aggravated by the HIV/AIDS pandemic, access to better nutrition has become a top priority. The potential of small kitchen gardens for vegetable cultivation is vast, especially as food prices are sky-rocketing. However, vulnerable households and HIV/AIDS-affected persons can not bear too much hard work. A simple drip irrigation kit is being promoted which eases the work of watering and weeding considerably and is – together with appropriate seeds, fertilisers and know-how – an effective way of increasing the supply of vegetables at the household level.

IDE started to work in Zimbabwe in 2003 and has experimented since then with small drip irrigation kits and vulnerable groups. Even today, it is difficult to find partners from the humanitarian aid scene willing to change their ways of working from distributing free gifts towards an approach where the beneficiaries pay for or at least contribute towards the investment. Now, IDE is working with the Adventist Development and Relief Agency (ADRA) and other agencies in disseminating the technology and know-how packages. By mid-2005, in one project, 5,000 irrigation kits suitable for 200 m<sup>2</sup> had been distributed and 600 in another. A 200 m<sup>2</sup> kit costs some US\$ 21 and can produce up to 1,400 kilograms of sweet potato in one crop cycle of 3 to 4 months; the commercial value is US\$ 300.

It is too early to measure the impact this programme upon food security, health and nutrition in Zimbabwe in its difficult economic situation. It is, however, more than evident that vulnerable households and especially HIV/AIDS-affected persons appreciate their small kitchen gardens. It has not been possible to convince the humanitarian aid agencies that they should not give away the drip kits free of charge, but the dissemination so far has already created a demand for them: IDE has already sold some 2,000 systems for US\$ 25 each.



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# **ANNEX: SPIRULINA AS A FOOD COMPLEMENT FOR HEALTH AND COGNITIVE DEVELOPMENT**

(by Denis-Luc Ardiét and Denis von der Weid)





## **SPIRULINA AS A FOOD COMPLEMENT FOR HEALTH AND COGNITIVE DEVELOPMENT**

by Denis-Luc Ardiet and Denis von der Weid

### **1. INTRODUCTION**

A person's brain development and cognitive abilities for their entire life are strongly determined by the nutritional status of both the child and his/her mother during the perinatal period. Micronutrients, proteins and essential fatty acids (EFA) are essential for the proper growth and structure of the brain as well as for the activity of multiple enzymes required in metabolic and signaling pathways. Malnutrition – that is, deficiencies in micronutrients – can be seen as a 'silent hunger' during which cognitive development is affected. During gestation, breastfeeding and the first two years of life, in particular, certain nutrient deficiencies have dramatic effects on brain development (1,37). Nutrition clearly determines the future learning, working and thinking performance of children.

In this paper, in addition to presenting a rapid review of some of the scientific knowledge about the impact of nutrition on brain development and functioning, we also recall some qualities of the algae-like Spirulina, very rich in nutrients that are essential for children's growth and health. Given the demonstrated impact of malnutrition on brain functions, Spirulina could represent a minimal but necessary and potentially efficient food complement. In November 2005, a resolution was drafted for the United Nations General Assembly which recognized the merits of Spirulina production and its "potential to enhance food security in environmentally compatible ways", "based on academic research and reports from the Food and Agriculture of the United Nations and the World Health Organization".

### **2. NUTRIENT DEFICIENCIES IN INDIA: SOME FIGURES**

In India, the population of undernourished children in the range of 0 - 6 years, is estimated at 85 million. Officially, only 34 million of these children are getting access to supplementary nutrition, but actual coverage is even far less. In spite of the widely-recognized and impressively-documented situation of hunger and malnutrition, there is no action plan giving priority to the elimination of hunger or micronutrient deficiencies.

In the year 2000, the Controller & Auditor General Report found one-fifth of rural households facing hunger and 40% of all households not getting two square meals a day. The National Family Health Survey (NFHS-2) admitted

that almost half (47%) of children under three years of age are underweight, and 46% are stunted. In India, the impact of calorie and protein supplementation has shown nearly no improvement for the below-poverty-line (BPL) population. In addition, the Indian Council of Medical Research (ICMR) published the results of various studies related to micronutrients, particularly in three basic public health areas:

- The overall prevalence of anaemia among pregnant women and children under 2 years is estimated to be over 80%.
- Vitamin A status among children is estimated to be below 50% of the recommended daily allowance (RDA) in most parts of the country.
- Iodine deficiency disorders (IDD) are indicated by a recent ICMR study (2001) with an average prevalence of 4.7%. More recent studies in Delhi slums indicate a prevalence of 23%, and of 56% in Bombay slums with a visible goitre rate of 11%. In spite of positive declining trends in recent years, cretinism is still widespread in some Eastern districts, according to Ministry of Health and Family Welfare (2002).

Various nutritional deficiencies, such as with vitamin B, vitamin C and vitamin D, are related to nutritional deprivation. For instance, children from 1-3 years in most States appear to be consuming less than 50% of the vitamin RDA. The situation with other micronutrient deficiencies (zinc, folic acid, etc.) is not sufficiently documented to be expressed with concrete figures, but they are recognized as being inadequate.

According to the National Nutrition Monitoring Bureau (NNMB), it is slum children who are the worst off in nutritional profiles. A National Nutrition Policy document and a National Plan of Action (1995) clearly defined objectives for the reduction of micronutrient deficiencies in children and lactating women. Unfortunately, a decade later, the goals still have not been achieved.

The reduction of hunger and malnutrition can only be achieved if there is a clear analysis of their causes. Available food resources in India are not only sufficient, in terms of calories, but there is a huge export of 20 million tons of grain out of India at almost BPL prices. Figures from 2002-2003 show that the entire midday meal scheme in India would almost be covered if these grain exports were allocated to hungry children. Furthermore, a Public Distribution System does exist, as a unique facility to provide food security for the poorest BPL population. Unfortunately, as has been well-documented in the Supreme Court (SC) Orders, the scheme is not working properly. Many States are refusing to distribute ration cards to the

urban destitute or to organize proper identification of BPL families. They do so in spite of the SC Order, using the excuse of the difficulties in selecting and identifying the BPL population.

### **3. NUTRITIONAL NEEDS FOR MENTAL DEVELOPMENT DURING LATE PREGNANCY AND THE FIRST TWO YEARS OF LIFE**

During the last three months of gestation and early infancy, the brain is a site of high activity, where cells divide and differentiate into neurons and accessory cells. During this period of growth, there is a great need for proteins, lipids and energy supply. Micronutrients, which serve as cofactors for many metabolic and signaling processes, are equally essential. These nutrients are normally brought prenatally by placental transfer to the fetus, and postnatally by breastfeeding.

#### **Iron**

It is important to keep in mind that the body's allocation of iron is always supplied as a top priority to red blood cells, over any other organ, including the brain (2): iron deficiency can be pathologic even before iron deficiency anaemia (IDA). In other words, iron homeostasis mechanisms are made in a way which first ensures production of red blood cells. Particularly, iron deficiency induces irreversible effects on the brain of a child if occurring during pregnancy or the first year of life.

One of the most important features of iron is its role in energy utilization in the respiratory chain of mitochondria. Studies in the rat model by De Ungria and colleagues demonstrated that iron deficiency was associated with a decreased energy metabolism in the hippocampus, a region involved in cognition and memory (3). This might explain the observations that iron deficiency in human neonates are associated with electrophysiological evidence of reduced recognition memory at birth (4). Second, iron is essential for myelin production because it is a co-factor for lipid biosynthesis.

As a consequence, IDA has been shown to be associated with myelin defects and slower transmission through the auditory and visual systems (5). This phenomenon is not reversible and persists despite treatment for IDA with iron supplementation. Finally, iron plays a role in the metabolism of monoamines, which constitute a group of neurotransmitters and neuro-modulators, particularly dopamine (6).

In several studies, iron deficiencies and moderate anaemia occurring during infancy were shown to affect cognitive

performance at school. These studies were controlled for the socio-economic background of children (7,8). In addition, iron supplementation is not always able to revert the low cognitive abilities of those children: mental development seems to occur in a 'window-period' during life, inside which damages can be irreversible.

One gram of Spirulina dry extracts contains about 0.6 to 1.8 mg of iron (9). It is much more than the highest content found in cereals (max. 0.25 mg/g). In addition, the bioavailability of iron from Spirulina has been shown to be high (10), as opposed to cereals – the latter contain high phytate levels which have a negative effect on the intestinal assimilation of cations. With such characteristics, Spirulina is an excellent dietary source of iron.

#### **Iodine**

Iodine is necessary for the synthesis of thyroid hormones, themselves being involved in the proper development and functioning of the brain (11). Goitre is a compensatory hypertrophy of thyroid occurring in case of iodine deficiency. Hypothyroidism can also result from such a deficiency. If occurring early in life, it first induces anorexia and constipations, and later on it induces cretinism, an irreversible form of mental retardation associated with growth retardation. Light to moderate iodine deficiencies can also induce mental impairments if occurring later in life.

Unfortunately, there is no detectable iodine in Spirulina. An adult roughly needs 200 µg (200 mcg/micrograms, or 0.2 mg/milligrams) of iodine per day, and slightly higher doses during pregnancy and lactation (250 µg). In contrast, iodine toxicity is very low, so that the World Health Organization considers daily intakes up to 1 mg as safe.

About one billion people suffer from iodine deficiency. China (300 million people), Latin America (200 million), and Africa and India (100 million) are the main regions where iodine is seriously lacking, as in several parts of Europe, and Indonesia. Main sources of iodine are seafood – mainly algae and fish (100 µg of iodine are brought by 100 mg of sea fish) – and salt supplemented with iodine.

#### **Vitamin A**

Vitamin A is a lipid-soluble vitamin whose precursor is pro-vitamin A, or -carotene. Its most known characteristic is its role in vision. Vitamin A is the precursor of retinal, which is associated with visual pigments such as rhodopsin. Deficiencies in vitamin A were once associated with night blindness. Early symptoms are defects

in adaptive night vision; if left untreated (by supplementation), symptoms of xerophthalmia appear: corneal opacity or necrosis, and total blindness.

If occurring early in pregnancy, vitamin A deficiencies can induce serious or lethal malformations, affecting the nervous system (spina bifida), the face or the limbs. Vitamin A plays also a role in the integrity of skin and the mucosa of the respiratory tract: vitamin A deficiencies induce detachment of the epithelium, and therefore a reduction in the capacity to eliminate respiratory mucus, the consequence of which being an increased susceptibility to infections.

Spirulina contains high levels of  $\beta$ -carotene (about a microgram per gram of Spirulina powder. It has been successfully used in a trial to treat children suffering from chronic vitamin A deficiencies: 1 g of Spirulina per day reduced the incidence of visual symptoms on these children from 80% to 10% (38).

### Zinc

Zinc is found in all human tissues; in particular, it is found in high concentrations in the brain. It is essential for the activity of a large number of metalloenzymes: the cellular functions are as wide as RNA and DNA synthesis, cellular growth, differentiation and metabolism. Early development – when cell activity is the highest – may be particularly sensitive to zinc deficiency. In some studies, it has been associated with reduced neuronal growth and brain volume. In addition, zinc deficiency has been shown to compromise activity, cognitive development and attention (12,15). In some studies, zinc levels have also been correlated with reading ability and academic performances. Finally, zinc supplementation studies have shown an effect on reasoning abilities (12).

One gram of Spirulina contains about 0.02 to 0.04 mg of zinc. The absence of phytates in Spirulina allows a much higher availability of zinc than from cereals. However, zinc levels brought by 10g of Spirulina remain much too low to reach recommended intakes (15-20 mg/day, WHO). Because of the almost ubiquitous role of zinc in biochemical processes, and in order to reach WHO recommendations, Antenna Technologies is developing zinc-enriched culture protocols in order to obtain Spirulina extracts containing 0.2 to 2 mg/g. In consequence, we shall recommend to our partners that they adapt Spirulina production to WHO standards with regard to zinc needs.

### Other micronutrients

Vitamin B1 (thiamin) plays a role in aldehyde transfer. The typical syndrome associated with its deficiency is

Beriberi, which includes weight loss, heart problems and neurological dysfunction. B1, B2, B6, B12 vitamins and folic acid have been shown to be needed for the synthesis of several neurotransmitters (13). The only sources of vitamin B12 are animal products: infants breastfed by mothers who do not consume animal products, and people who do not consume them, are at risk of vitamin B12 deficiencies. Vitamin B12 deficiencies typically induce pernicious anaemia, but in addition, they have been associated with neurological defects. Studies on children with vitamin B12 deficiencies reported a slower perception, memory or reasoning, lower academic performance and delinquent behaviours (14,15). Vitamin E (tocopherol) is a fat-soluble vitamin. It is a strong anti-oxidant: it interacts and neutralizes reactive oxygen species such as hydroxyl radicals before they can oxidize unsaturated membrane lipids and damage cell structures. Therefore, vitamin E plays an essential role in maintaining cell integrity, a crucial parameter for neuron structure and function. Vitamin E deficiency can lead to night blindness.

Table 1: Approximate composition of various vitamins (mg) in Spirulina (dry extract) (see next page)

### Essential fatty acids

Essential fatty acids (EFA) are polyunsaturated fatty acids. Two groups exist: the n-3 and n-6 families of EFA. Linolenic acid, the precursor of the n-3 family, gives rise to DHA (docosahexaenoic acid) while linoleic acid (LA) is the precursor of various types of n-6 fatty acids such as arachidonic acid (ARA). Both DHA and ARA are found in cell membranes, but their concentration is particularly high in the central nervous system.

The first degree of importance of EFA is that they affect the structural composition of neurons. In neuronal membranes, EFA affect membrane fluidity, membrane thickness, membrane microenvironment; they interact with membrane proteins, and n-3 deficiencies are associated with alterations in receptors, transport, and cellular interactions. For example, it has been shown that DHA supports the function of rhodopsin in vision, allowing a greater mobility of rhodopsin in the membrane bilayer (16). Animal studies showed that n-3 fatty acid deficiencies during pregnancy are accompanied by abnormal retinal responses to light in newborns (17,18). Restrictions of n-3 fatty acid intake during the prenatal period have long-term effects on retinal fatty acid composition and function and cannot be reversed by early n-3 fatty acid repletion (19). The importance of the integrity and physical properties of neuronal cell membranes (20) is also illustrated by learning and behavioural defects observed in animal studies of n-3 fatty acid dietary deficiencies (21). Second, n-3 and n-6 polyunsaturated

Vitamin	Amount (mg) per 10g of Spirulina	Recommended intake per day (mg)	Main clinical manifestation of deficiency	Digestive	Mucosal/cutaneous	ocular	neuromuscular	psychiatric	cardiac	hematological
Vitamin B1	0.34-0.50	1.50	Beriberi							
Vitamin B2	0.40	1.80	Dermatitis				•	•	•	
Vitamin B6	0.05-0.08	2.0	Dermatitis, Depression, anaemia		• •	•		•		•
Vitamin B12	0.015	0.003	Pernicious anemia				•	•		•
Niacin (B3)	1.3	20.0	Pellagra							
Folate (B9)	0.005	0.4	Diarrhea, loss of appetite, behavioural disorders	•	•		•	•		•
Panthenate	0.046-0.25	6-10	Mild, aspecific (headache, fatigue)			•				
Biotin	0.0005	0.1-0.3	Dermatitis, mental health		•			•		
Vitamin E	0.5-1.9	12	Neuromuscular degeneration				•			•

fatty acids are involved in the differentiation of precursor's cells into neurons. Third, the polyunsaturated fatty acid DHA can affect levels of various neurotransmitters, in specific regions of the brain (13). Dopamine, particularly, plays a role in cognition in early childhood as a modulator of attention and motivation, as well as in visual processes (22).

The best source of EFA for infants is breast milk. While the total EFA content is a parameter to consider assessing the quality of breast milk, another parameter is the ratio n-6/n-3. FAO and WHO recommend this dietary ratio to be between 5/1 and 15/1. Therefore, the diet of pregnant and lactating mothers has to be sufficient both for n-3 and n-6 EFA, n-3 fatty acids usually being the limiting product. Communities should be informed about the importance of EFA in health:

Fat diets containing n-3 and n-6 EFA are for example: breast milk, fish, soybean, linseed, sesame, canola oil. Fat diets containing n-6 only (with no n-3 EFA) are: Spirulina platensis (40% of total fatty acids, about 3% of total weight in dry extracts (9)), corn, sunflower, safflower, olive oil, and seeds from other plants such as Moringa oleifera.

### Protein-energy

Protein-energy malnutrition (PEM) should be categorized as 'undernutrition' rather than 'malnutrition'. It is caused by insufficient intake of proteins and/or calories (lipids and carbohydrates). Roughly, two forms of PEM exist: marasmus, due to a deficiency in both proteins and calories intakes, and kwashiorkor, which results from a deficiency in proteins only. The psychomotor, cognitive and behavioural defects associated with kwashiorkor have been reviewed by Carol Thompson and Ernesto Pollitt (23): "apathy, irritability, anorexia, and withdrawal", while neurological symptoms are "hypotonia, poorly developed motor skills, and occasionally, cortical and subcortical atrophy". Regarding the marasmic condition, behavioural and neurological data reflect "a reduced activity, hypotonia, cortical atrophy, and reduced brain weight". In several studies, malnourished children have been found less responsive to environmental stimuli than children with normal weight; this has been attributed to a decreased attention. Rehabilitation from malnutrition could not attenuate this defect.

Spirulina is a food complement, which has to be added to regular meals in amounts varying from 1 to 5 g. By itself, it can not bring the amount of proteins necessary for the development of children (estimated at about 10 to 15 g per day in the first year of life), but it contains substan-



tial amounts of essential amino acids. Dry weight of Spirulina is composed of about 60% of proteins, with small variations depending on culture conditions. This exceptional level of proteins is far above those found in other organisms. Most importantly, the quality of these proteins is complete, since all of the 20 amino acids – including 'essential' amino acids, which mammals cannot synthesize – are represented (table 2, (9)). An additional feature of proteins found in Spirulina is their high accessibility and ability to be digested and absorbed in the intestine. Finally, animal studies on weight gain using dietary Spirulina food demonstrated a high proteinic efficiency, with a mean value of 1.90 (9).

Table 2: Spirulina essential amino acids content (mg) in 1 gram of extract: percentages of child daily requirements covered by 1g of Spirulina.

Essential amino acids	Spirulina content, in mg per g	Percentage of daily requirements (child 0-12 months)	Percentage of daily requirements (child 1-5 years)
Histidin	1	0.3%-0.5%	0.1%-0.3%
Isoleucin	35	5%-8%	5%-8%
Leucin	54	3%-5%	1%-3%
Lysin	29	3%-4%	1%-2%
Methionin	14	2%-4%	1%-2%
Phenylalanin	28	2%-3%	1%-2%
Threonin	32	4%-6%	1%-3%
Tryptophan	9	5%-8%	2%-5%
Valin	40	4%-7%	2%-4%

#### 4. COGNITIVE DEVELOPMENT AND CHILD STUNTING

Single micronutrient deficiencies are associated with specific pathologies. However, it is well known that a deficiency in one single nutrient is rare in clinical practice: children usually suffer from multiple micronutrient deficiencies, one consequence of which being stunting.

Stunting is a consequence of chronic malnutrition in early life either prenatally, postnatally, or both. About a third of children in developing countries are stunted (24). They have smaller head size, poor neuromotor development manifesting as clumsiness or incoordination, lack of vigour and enthusiasm, poor scholastic performance and absenteeism in school (13). In a study of more than 2,000 Filipino children in 1999, Mendez et al. showed the negative consequences of malnutrition on cognition and schooling. Stunting between birth and the age of two years was chosen as the discrimination factor between children. Severe or moderate stunting resulted in lower scores in cognitive tests at ages eight and 11, as compared to non-stunted children (25). It is to note that the timing of stunt-

ing also affected test scores, earlier stunting resulting in lower results.

In another study, Walker et al. (26) have shown that food supplementation (milk-based based formula) induced benefits on development in stunted children, but they have shown that this effect was not long-lasting up to 11 years of age. However, this study has highlighted the importance of psychosocial stimulation on cognition: the benefits brought by early social stimulation (designed to improve mother-child interactions) for stunted children have been shown to be long-lasting, even without any food supplementation: at 17 and 18 years of age, children have caught up cognitive scores obtained by non-stunted children. From this study, the child's environment appears as important as nutrition to allow an optimal development of children.

#### 5. INFECTIONS AND COGNITIVE DEVELOPMENT

Biomedical research has brought the evidence that both malnutrition and undernutrition are associated with an increased susceptibility to infections, as well as cancer, auto-immune and neurodegenerative diseases. The immune system needs a complete intake of nutrients to efficiently fight pathogens, undesirable cells or to distinguish correctly the 'self' from the 'non-self'.

Infectious diseases, themselves, have been linked to behaviour and cognitive development. Several studies have demonstrated a positive correlation between cognition defects and malaria (27-29), cerebral meningitis (29), intestinal parasites (30), or HIV/AIDS (31,32). The two major reasons are, firstly, a direct effect of these pathogenic events on brain functions, and, secondly, school absenteeism due to sickness and recovering time. Given the importance of nutrition in the efficiency of the immune system in the fight against various pathogens, for which a number of reviews decrypt the underlying mechanisms (33), access to highly-nutritive foods can help the

mental development of children by the reinforcement of immunity.

## **6. FOOD FORTIFICATION WITH SPIRULINA AND CHRONIC MALNUTRITION: STUDIES AND EVIDENCES**

In many countries, supplementation policies may have limited effects because populations suffer from several – sometimes many – deficiencies. They may also be inefficient if provided out of the 'time window' of early brain development. Supplementation policies bringing several nutrients may have a better impact on health. Furthermore, given the impact of infectious diseases on mental and cognitive development of children (27-33), it is likely that micronutrient supplementation would further enable children's cognition through a reinforcement of immunity. Finally, the study of Walker et al. (26) illustrates the need for strengthening physical and psychosocial stimulation of infants. This parameter has even been recently included into recommendations by the World Health Organization (WHO) (34). From the literature, the combination of enhanced stimulation and appropriate nutrition is expected to have a strong and long-lasting effect on children's cognition and behaviour.

In situations of poverty, complementation of traditional meals with the algae-like Spirulina – which contains high levels of essential micronutrients such as iron, vitamin A, B1 and B2, as well as macronutrients such as EFA and proteins – is a promising source for food fortification. Vitamin A and iron, associated together, may efficiently reduce the incidence of a large number of mental diseases – or disabilities – attributable to nutrient deficiencies. The presence of EFA in Spirulina is interesting, although n-3 fatty acids are lacking; other dietary sources of iodine (sea fish, sea algae) or n-3 fatty acids (fish, vegetable oils such as soybean, sesame, and canola) need to be made available. Animal sources of nutrients (milk or meat) also contain large amounts of essential nutrients (iron, zinc, proteins).

The complementation of meals with Spirulina could be a solid and cost-effective option to provide to the most vulnerable populations a solid basis of physical and mental health. In one of the projects started by Antenna Technologies in the Democratic Republic of the Congo (DRC), a mixture of three cereals mixed with Spirulina, water and sugar is currently being provided to 2,500 children suffering from mild or severe malnutrition. This meal, named SOSPISOMA (100 g sorghum, 15 g Spirulina, 100 g soya, 200 g corn (maize), sugar and 1 liter of water), is more efficient for rehabilitating children than that provided without Spirulina complementation (Zaccharie Kasongo,

personal communication). In Burkina Faso, Jacques Simpore et al. (36) have shown that daily supplementation with Spirulina, added for eight weeks to MISOLA (a nutritional complement for children widely used in West Africa primarily comprising millet, soya, peanut kernel, sugar, salt and water) was efficient in rehabilitating undernourished children. The Misola meals, without Spirulina, have a high nutritional value and are distributed to malnourished children or convalescent people; the combination with Spirulina powder is more efficient for rehabilitation. Finally, the experience from our partners in the field is worth to report: Sr Valérie Kingombe, working in a dispensary in Goma/Himbi (RDC) reported that "People living with HIV/AIDS are the first beneficiaries of Spirulina because they recovered physical strength due to an enhanced appetite", "several people suffering from diabetes recovered their strength", "a young patient suffering from tuberculosis became more healthy". These are just some of the many evidences which we regularly collect and aim to further validate in a scientific way.

## **7. RECOMMENDATIONS AND CONCLUDING REMARKS ON SPIRULINA'S BENEFITS**

Let us go back to the situation in India, where the disastrous burden of child malnutrition, undernutrition and low birth weight children will require time to be overcome. Even if all the States have enough food to provide to the BPL population, and particularly to children and lactating women, the political will to implement adequate schemes through a midday meal programme is not demonstrated and is not operational. These are the main reasons why NGOs are urgently requested:

to reduce mass-scale nutrition insecurity by asking the Union of India to ensure that the SC Orders are implemented.

- to act politically in obtaining adequate funds available from the States to combat child malnutrition.
- to improve the nutritional status of children in the range of 0-6 years by providing supplementary food and particularly micronutrients.
- to provide pregnant and lactating women with adequate food and micronutrients.
- to facilitate access to Spirulina to all Anganwadi Centres (AWCS). Many of the Centres are not operational, as in the case of Bihar, Uttar Pradesh and Jharkhand. The SC recommended that one Centre should be provided for each 1,000 people. It seems that only 600,000 out of 1,400,000 have been sanctioned. The Order (August 2004) also directed the Government of India to revise the supply of nutritious food worth 1 rupee to 2 rupees per child per day.

There is no point in recognizing the importance of eliminating micronutrient malnutrition without promoting the evidence of optimal breastfeeding and infant feeding practices. Whatever micronutrient policy or health care system is implemented, breastfeeding practices have to be made an integral part of all nutrition interventions. In addition to children, the integration of pregnant and lactating women in Spirulina programmes should be considered.

The concept of these interventions – breastfeeding and improvement in nutritional status with micronutrient supply – should be community-based. In India, we should make use of the great advantage of distribution through existing services such as ICDS, AWCS or mobile crèches (city working women on construction sites). Such centres should first be approached to encourage the adoption of a balanced mix with Spirulina. These centres could also be a platform for nutrition education and demonstration. It needs qualified NGOs to collaborate in these efforts of nutrition training and pedagogy. Finally, we cannot overlook the most difficult handicap of all in achieving such a role in slums: safe drinking water, and the difficult improvement of environmental sanitation and hygiene.

Antenna does not envisage any other role for Spirulina than as a food complement. In our programmes it is added to traditional meals as a source of essential nutrients such as iron or vitamin A. These elements are frequently lacking in available food, even though populations often have 'enough' to eat. Nonetheless, defeating malnutrition depends not only on supplementation programmes such as Spirulina production, but local autonomy and proper structural agriculture policies too. The strengths of Spirulina-based complementation programmes are several. First of all, Spirulina brings a 'cocktail' of essential nutrients. Second, it is very well-accepted by the population for several reasons, mainly due to improvements in health and well-being. Thirdly, Spirulina production can be local; it requires a low-cost technology, warm temperatures and sufficient light and is thus very suitable for tropical countries. A minimum of knowledge is required to manage a production unit, whereas adaptations or improvements are possible.

While the positive effects on immunity and physical growth are starting to be well-documented, more clinical and scientific studies are necessary to further investigate the benefits of Spirulina on cognition. We expect that consumption of Spirulina-enriched meals by young infants and pregnant/lactating mothers will lead to:

- a) decreasing the incidence of mental diseases due to severe micronutrients deficiencies;
- b) improving children's performances at school;
- c) enhancing cognition of adults as workers and citizens.

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## POVERTY ALLEVIATION AS A BUSINESS - THE MARKET CREATION APPROACH TO DEVELOPMENT

is the title of the original study by the author of this - unrevised - 2006 volume, Urs Heierli. Published in March 2000, it summarised the experiences of his 12 years working as country director of SDC in Bangladesh and India (1987-1999).

Can poor people make a business with goods and services that are relevant for poverty alleviation? The answer is yes, as the six examples of the original study show. To make it happen, markets should be created and technologies must be validated, tested and introduced. If a critical mass of demand is created, small private enterprises will emerge to respond to these new business opportunities.

The following six examples are examined in detail. They are analysed according to the 4 Ps of marketing (Product, Price, Place and Promotion) and various performance parameters, especially in view of the potential for scaling them up and replicating them in other countries.

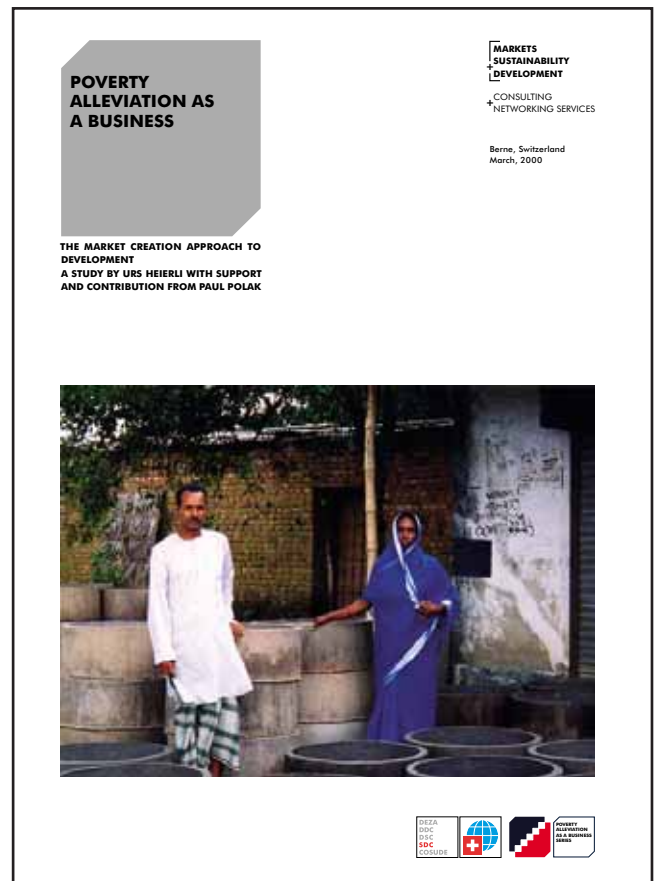
1. 'Hundred million trees as a social insurance scheme: the village and farm forestry programme in Bangladesh'
2. 'Pedalling out of poverty with the treadle pump in Bangladesh, India and Nepal'
3. '60 kilograms more maize per family with "Postcosecha" silos in Central America'
4. '2'000 micro-concrete roofing workshops produce over 150'000 roofs per year'
5. '6'000 private workshops produce over one million latrines per year in Bangladesh'
6. 'The rope pump in Central America: the scope for private drinking water supply'.

### ORIGINAL PUBLICATION:

Poverty Alleviation as a Business - The Market  
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SDC Berne, March 2000

Hardcopies of the original publication  
can be ordered from  
SDC, Employment and Income Division  
Freiburgstrasse 130  
CH-3003 Berne Switzerland  
email: [e-i@deza.admin.ch](mailto:e-i@deza.admin.ch)

Electronic copies can be downloaded  
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## POVERTY ALLEVIATION AS A BUSINESS (NEW SERIES)

A new series of case studies will provide deeper insights into the 'Market Creation Approach to Development' as a follow-up to the original study (see inside back cover).

Several case studies on supply chains or value chains are planned, such as:

- Sustainable Approaches to Combat Malnutrition - Small-scale Production and Marketing of Spirulina
- Ending Poverty with Water Control and Market Access
- One Fly is deadlier than 100 tigers - Total Sanitation as a Business and Community Action in Bangladesh
- Marketing water purification to the poor (working title)
- Connecting Fashion Designer and Farmer - the Organic Cotton Value Chain (working title)
- Making Insecticide Treated Mosquito Nets Affordable without Destroying the Supply Chain (working title)
- For the latest information: visit [www.povertyalleviationasabusiness.org](http://www.povertyalleviationasabusiness.org)

## SUSTAINABLE APPROACHES TO COMBAT MALNUTRITION

describes the experience of Antenna Technologies, a Geneva-based NGO, with small-scale production of Spirulina and its use as a tool to combat malnutrition. Spirulina is an algae growing naturally under tropical conditions in alkaline water and can be cultivated in small ponds with little investment. (More information: [www.antenna.ch](http://www.antenna.ch))

Spirulina has five key assets in combating malnutrition:



**1. It is cheap:** to feed a child in India costs between one and two Rupees a day (US\$ 6 to 12 per year). Many other feeding solutions are more costly and less sustainable.

**2. It is effective:** one gram per day is enough to correct severe malnutrition in a child in a few weeks. New studies suggest that Spirulina not only improves the physical development of the child but also cognitive performance. Spirulina helps people affected by HIV/AIDS to feel better in their daily life and gain weight;

**3. It is a relatively simple process** and requires a low investment of only US\$ 500 per tank (18 m<sup>2</sup>) producing 150 grams per day and the technology is fully mastered;

**4. It provides income:** Spirulina cultivation is ideal work for rural women, as a labour-intensive and caring job;

**5. It is a local business:** Spirulina production can be organised as a decentralised rural industry and can involve local people. They can produce, process and sell Spirulina as a business and generate rural income. It is thus a sustainable long-term solution.

