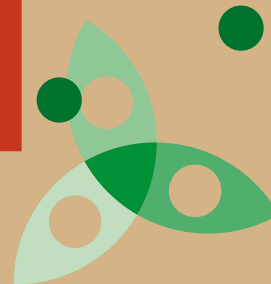


nutrition

The international magazine for nutrition practitioners in developing countries



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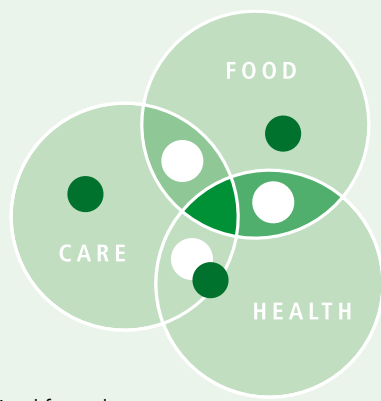
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Pull-out poster



The **nutrition** symbol is derived from the three key areas essential to nutrition: **food, health and care**. Out of each of these, seeds of ideas and experience disperse.

Editorial team

Carmel Dolan, Kerry Selvester, Fiona Watson

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by email editors@nutritioninternational.org.uk

Statistics on children under five provided at the start of each of the country-based articles in this issue use the following definitions.

- **Underweight** refers to weight-for-age less than minus two standard deviations below the median of the reference population. This results from wasting or stunting or a combination of both.
- **Wasting** refers to weight-for-height less than minus two standard deviations below the median of the reference population. Wasting, or thinness, develops as a result of recent rapid weight loss or a failure to gain weight.
- **Stunting** refers to height-for-age less than minus two standard deviations below the median of the reference population. Stunting, or shortness, develops over a long period of time.

Acronyms

| | |
|---------------|--|
| EAR | Estimated Average Requirement |
| FAO | Food and Agriculture Organisation |
| GAIN | Global Alliance for Improved Nutrition |
| GDP | Gross Domestic Product |
| Hb | Haemoglobin |
| IDA | Iron deficiency anaemia |
| ITN | Insecticide treated mosquito net |
| IVACG | International vitamin A consultative group |
| INACG | International nutritional anaemia consultative group |
| MICAH | MICronutrient And Health programme |
| PCV | Packed cell volume |
| RBC | Red blood corpuscles |
| RDA | Recommended daily allowance |
| RDT | Rapid diagnostic test (for malaria) |
| SF | Serum ferritin |
| TtR | Transferrin receptor |
| UNICEF | United Nations Children's Fund |
| USAID | United States Agency for International Development |
| WFP | World Food Programme |
| WHO | World Health Organisation |

Solving the anaemia epidemic

Fiona Watson, Carmel Dolan, Kerry Selvester *Editors*

The third issue of *nutrition* focuses on the intractable problem of anaemia. It affects so many people and yet seems so difficult to prevent and treat.

Around two billion people in the world today suffer from anaemia – that is equivalent to over 30 per cent of the entire world population. Most anaemia is due to iron deficiency, the most common nutritional disorder in both developing and developed countries. WHO reports that anaemia affects more people than any other condition, constituting a public health problem of epidemic proportions. The toll in terms of ill-health, premature death, impaired child development and lost earnings is enormous. According to the World Bank, eliminating anaemia would result in a 5–17 per cent increase in adult productivity, which adds up to two per cent of Gross Domestic Product (GDP) in the worst affected countries.

Despite the widespread nature of iron deficiency and anaemia, little impact has been made on eradicating these problems. Increasing iron intake through dietary diversification has been promoted for many years and Brian Thompson argues in *Viewpoint* that food-based strategies are still essential to combat iron deficiency anaemia (IDA).

Iron supplementation, especially of at-risk groups such as pregnant women and young children, is a mainstay of most government maternal and child health programmes. Yet it has been remarkably unsuccessful in preventing and treating anaemia. This is partly due to a lack of compliance and, as Omar Dary points out in *Combining strategies*, can only be successful where iron is the main micronutrient deficient in the diet. Because a whole variety of micronutrients are needed to enhance the absorption and metabolism of iron, a lack of other micronutrients will mean that supplementation with iron is not successful. The author recommends addressing all micronutrient deficiencies through using a combination of strategies.

Food fortification has received increasing support in recent years as a means of combating anaemia. An article from **Vietnam** by Pham Van Thuy outlines plans to fortify fish sauce; a widely consumed condiment which could meet a third of an adult woman's iron requirements. The fortified fish sauce will cost slightly more and time will tell whether the consumer is prepared to pay the extra cost.

An innovative way of improving the iron intake of children in

India is described by Saraswati Bulusu and Tripti Pant Joshi.

Nutri-candy is a sweet lozenge which has been given to children attending supplementary feeding centres. The results have been astonishing with very high compliance rates and a 15–50 per cent reduction in anaemia. The lozenges contain sugar, however, which could potentially contribute to dental caries.

Home fortification through Sprinkles is being tried out in **Mongolia**. Colleen Emary and S M Ziauddin Hyder describe how sprinkling a sachet of Sprinkles into semi-liquid, cooked food has contributed to a reduction in anaemia among children under five years of age. Sprinkles were well accepted by the families where the programme was introduced and compliance was high. Sustainability will again depend upon whether families are able and willing to pay for Sprinkles in the future.

Infectious diseases, such as malaria, HIV/AIDS, hookworm infestation, schistosomiasis, and other infections such as tuberculosis contribute to the high prevalence of anaemia in some parts of the world. Elizabeth Streat notes that in parts of **Mozambique**, where malaria is highly endemic, it is malaria and not dietary factors that are the principle cause of anaemia. Studies have found that malaria is highly associated with anaemia. Preventing malaria, therefore, should help to reduce anaemia.

An article by Barbara Main focuses on a 10-year programme in four African countries: **Ghana, Malawi, Senegal and Tanzania**. The Micronutrient and Health (MICA) programme successfully reduced anaemia through a series of interventions aiming to increase intake, decrease disease and build local capacity. The project worked to integrate their activities into existing services and structures in an effort to ensure sustainability.

Andrew Hall coherently outlines *The basics* of anaemia and iron deficiency that we should all know. The *Resources* page provides information on how to get hold of useful material relating to anaemia and iron deficiency, most of which is free. On the *Letters* page we have included a small sample of feedback from our diverse readers.

Finally, this issue includes a colourful poster to put up as a reminder of the main ways of addressing anaemia. There are solutions to the challenge of anaemia, as the articles that follow show. Enjoy reading!



Spicing with iron

Fortifying fish sauce in Vietnam

Children under five 2000–04

| | |
|-------------|-----|
| Underweight | 28% |
| Wasting | 7% |
| Stunting | 32% |

UNICEF Global database on child malnutrition

Up to 30 per cent of the daily-absorbed iron needs for adult women of reproductive age may be met with an average consumption of fish sauce



Vietnam is planning large-scale fortification of fish sauce with iron. Fish sauce is widely consumed and fortifying it with iron has been shown in trials to reduce anaemia and increase iron status. How will fortification work in practice?

Micronutrient deficiencies have many invisible economic effects that are widely underestimated. They sap the energy of working people and limit the learning ability of children, causing billions of dollars in lost productivity in developing countries. Deficiency of vitamin A, iodine and iron could waste as much as five per cent of Gross Domestic Product (GDP), but addressing them comprehensively and sustainably would cost less than 0.3 per cent of GDP.¹

Iron deficiency anaemia (IDA) is a major public health problem in Vietnam. According to a survey carried out in 2000, the prevalence of anaemia among women of childbearing age was 24.3 per cent and 32.2 per cent in pregnant women. Significantly, the rate of IDA among infants under six months was 57.2 per cent, and IDA continued to be present in 34.1 per cent of children up to five years of age. Anaemia prevalence was found to be high in all regions of the country, but it was greatest in rural areas.²

The country's commitment to control iron deficiency is demonstrated by the 1998 adoption of a strategy to implement IDA control nationwide. The Prime Minister reaffirmed this commitment with the 2001–2010 ratification of Vietnam's National Nutrition Strategy.

Vietnam is one of seventeen countries receiving grant support from the Global Alliance for Improved Nutrition (GAIN). In Vietnam, the grant is for large-scale fortification of fish sauce with iron.

Research in Vietnam has demonstrated that iron fortification of fish sauce can improve the iron

GAIN

GAIN's mission is to reduce malnutrition through the use of food fortification and other strategies aimed at improving the health and nutrition of populations at risk.

GAIN was established in 2002 and has a key alliance-building function, bringing together both public and private partners around common objectives, and provides financial support and technical expertise. A distinctive and essential feature of GAIN's approach is its work with the private sector, applying innovative business models to make markets work sustainably for the benefit of those suffering from malnutrition.

GAIN has set itself the target of reaching 1 billion people by 2008. The longer term target is to reach the estimated 2 billion people across the globe suffering from nutritional deficiencies. www.gainhealth.org

status and reduce the prevalence of anaemia in the general population.^{3,4} In a randomized, double-masked efficacy study of 152 anaemic (Hb of 81–119 g/L) women, a meal based on noodles or rice was served six days a week with 10 millilitres of fish sauce containing either 10 mg of iron or no added iron (control group). Concentrations of haemoglobin (Hb), serum ferritin (SF), and serum transferrin receptor (TfR) were measured at baseline and after three and six months. After six months Hb and SF concentrations were higher and TfR concentrations were lower in the iron-fortified

group than in the control group. The prevalence of iron deficiency and iron deficiency anaemia was lower in the iron-fortified group than in the control group (32.8 per cent compared with 62.5 per cent [$P = 0.0005$] and 20.3 per cent compared with 58.3 per cent [$P < 0.0001$], respectively).³

Fish sauce is widely consumed by the Vietnamese people and centrally processed. It is therefore an excellent food source to fortify. The programme goal is to make iron-fortified fish sauce available at an affordable cost to all Vietnamese people and reduce the prevalence of IDA by increasing the daily dietary intake of absorbed iron.

The programme began in October 2005 and will be fully implemented after five years. Gradually, around 20 of the largest fish sauce factories will be supported to produce and distribute iron fortified fish sauce within three years in amounts that represent 60 per cent of the total market. After three years, production of iron fortified fish sauce will increase to 70 per cent of the total market by increasing market share per factory and expanding to include production by smaller factories.

The fish sauce will be fortified at a level of 4 mg iron (as NaFeEDTA)/10 ml of fish sauce. With the high bioavailability of NaFeEDTA, up to 30 per cent of the daily-absorbed iron needs for adult women of reproductive age may be met with an average consumption of fish sauce.

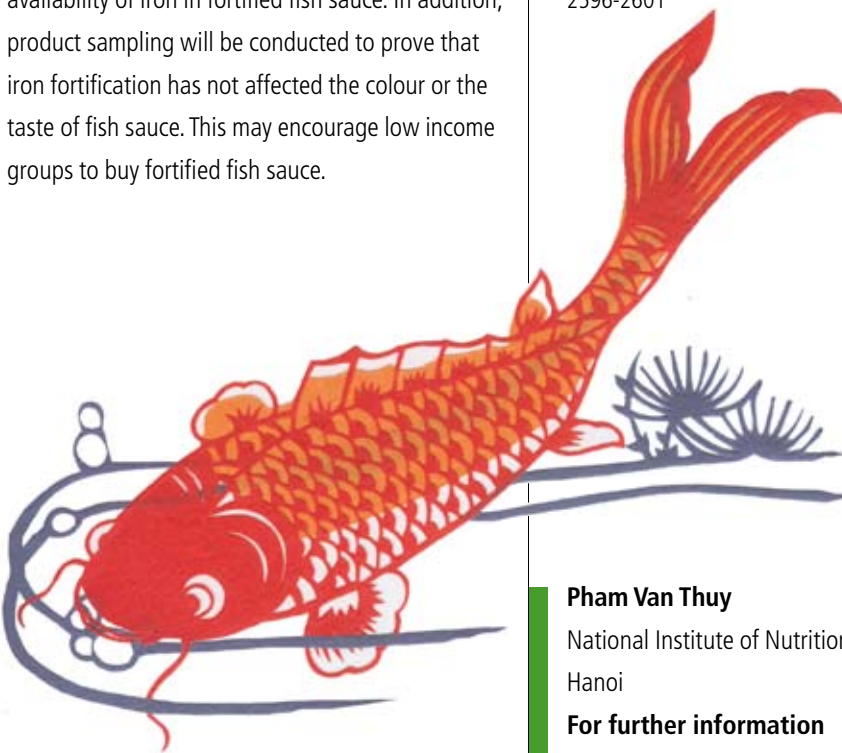
It is estimated that after 18 months of intervention, anaemia will be reduced in 5 per cent of low income and poor non-pregnant women of reproductive age in programme sites. After five years, as many as 42 million at-risk women and children will gain 26 per cent or more additional intake of their estimated average requirement of absorbed iron. The added cost of the fortificant is estimated to be US\$0.028 per litre or US\$0.16 per person per year, based on a normal consumption of 5.4 litres per year per person.

One month prior to the start of production of iron fortified fish sauce, each factory will have a production quality assurance system in place that meets government guidelines as determined by audits and inspection. After two years, the National Institute of Nutrition will carry out an impact



assessment of fortified fish sauce on the prevalence of IDA. Ongoing surveillance of dietary iron status will be conducted with at-risk women through blood sampling and testing for haemoglobin of populations in areas where access to fortified fish sauce has been established.

The major risk to the programme, is the additional cost of fortified fish sauce in comparison with non-fortified fish sauce. This may deter the poor from buying the fortified fish sauce. Prior to the launch of the fortified fish sauce, a social marketing plan will be completed. This will include an education and awareness campaign that will increase the population's knowledge and understanding of the need for dietary iron and the availability of iron in fortified fish sauce. In addition, product sampling will be conducted to prove that iron fortification has not affected the colour or the taste of fish sauce. This may encourage low income groups to buy fortified fish sauce.



NIN staff monitoring the fortification procedure in Cat Hai plant
NIN 2003

1 *Enriching lives: overcoming vitamin and mineral malnutrition in developing countries*
The World Bank, 1994.

2 Report on Vietnam National Anemia Survey, 2000
NIN/MOH, 2001.

3 Regular consumption of NaFeEDTA-fortified fish sauce improves iron status and reduces the prevalence of anemia in anemic Vietnamese women.
Pham Van Thuy et al. *The American Journal of Clinical Nutrition* 2003; 78: 284-90

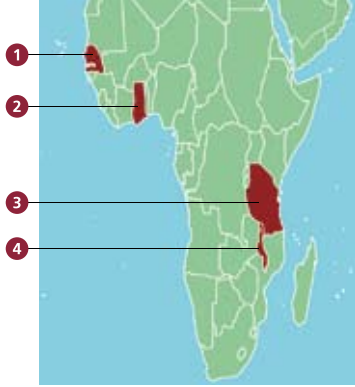
4 The use of NaFeEDTA fortified fish sauce is an effective tool for controlling iron deficiency in women of childbearing age in rural Vietnam. Pham Van Thuy et al. *Journal of Nutrition* 2005; 135: 2596-2601

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Involving communities

Reducing anaemia in African children through an **integrated approach**

Children under five 2000–04

| | | |
|-------------|----------|-----|
| Underweight | Senegal | 23% |
| | Ghana | 22% |
| | Tanzania | 22% |
| | Malawi | 22% |
| Wasting | Senegal | 8% |
| | Ghana | 7% |
| | Tanzania | 3% |
| | Malawi | 5% |
| Stunting | Senegal | 25% |
| | Ghana | 30% |
| | Tanzania | 38% |
| | Malawi | 45% |

UNICEF Global database on child malnutrition

- 1 Senegal
- 2 Ghana
- 3 Tanzania
- 4 Malawi

Child eating mango
World Vision 2004



Anaemia levels are high in Africa and notoriously difficult to improve through single interventions. The 10-year MICAH programme attempted to reduce micronutrient malnutrition, including anaemia, through a combination of interventions.

The Micronutrient and Health (MICAH) programme was a large-scale programme supported by World Vision Canada, and funded by CIDA (the Canadian International Development Agency). It aimed to reduce micronutrient malnutrition through integrating health and nutrition strategies in a target population of 2.7 million people. The programme was implemented in five countries; between 1996 and 2006 in Ethiopia, Ghana, Malawi, and Tanzania and between 2002 and 2006 in Senegal. In Ethiopia, anaemia was not addressed as it was not deemed a public health problem.¹

Some of the activities aiming to reduce anaemia are described below. While iron supplementation was a key activity, dietary strategies were also

supported. The small animal revolving fund aimed to increase iron intake from animal sources. Pairs of rabbits, chickens, goats and guinea fowl were distributed to selected households within villages. The offspring of these pairs were shared with other households who were able to breed animals and share offspring with more households. Each household involved was required to construct animal shelters in accordance with Ministry of Agriculture training.

Community members received nutrition education about the importance of eating animal foods which are high in iron. Community members were educated to view their animals as a source of food first then income. Since the consumption of

MICAH programme overview

Goal To improve the nutrition and health status of women and children through the most cost effective and sustainable interventions.

Objectives

Increase intake and bioavailability of micronutrients (iron, iodine and vitamin A)

Activities

- Provide supplements
- Fortify foods
- Promote exclusive breastfeeding
- Support dietary modification

Decrease diseases that affect micronutrient status (diarrhoea, parasitic and vaccine-preventable illnesses)

- Improve clean water and sanitation
- Support immunization
- Support malaria control
- Treat for worms and parasites

Build local capacity for delivery systems to improve micronutrient status

- Equip labs
- Produce MICAH guide
- Train staff
- Influence national policy and compliance to policy

rabbit meat was new to most project communities, significant effort was required in introducing the concept. Cooking demonstrations and taste-tests involving influential members of the communities, particularly religious leaders, proved an effective means of overcoming initial resistance.

Community leaders appointed a committee responsible for the revolving fund and identified recipient households. These often included an influential and respected community member whose example people would follow. Alternatively, the poorest families would be identified so that the community would see the impact of this initiative

What is a revolving fund?

A revolving fund is a method for continuously distributing supplies. An initial stock of supplies, for example mosquito nets, is supplied to a number of individuals who have been selected according to criteria determined within the community. Proceeds from the sale of the nets go into a revolving fund for the purchase of more nets.

The community manages the revolving fund and determines what contribution each person should make to maintain the stock. For example, poor people may receive nets free while better off individuals pay the full price.

among the most needy. The programme was adapted to suit the unique characteristics of each community.

MICAH also established household and communal gardens. Communities were encouraged to cultivate vitamin C rich fruits that enhance iron absorption, vitamin A rich fruits (mango, papaya), and indigenous dark green leafy vegetables. Solar driers were introduced to preserve fruits and vegetables, as a year-round source of micronutrients. Resource sharing was encouraged. For example, seed revolving funds were set up whereby seeds were collected at harvest and shared.

Anti-malarial tablets were distributed to pregnant women by MICAH in collaboration with local health services and volunteers. Drug revolving funds were set up in project villages. Community committees were formed and trained to operate



Woman with guinea fowl, Malawi
World Vision 2004

and manage the funds, which increased community accessibility to treatment for malaria and other common illnesses. Malaria prevention training was carried out and revolving funds for insecticide treated mosquito nets (ITNs) set up. The initial supply of ITNs was purchased by MICAH and resold to the community. The poorest in the communities received nets at no charge.

Capacity building was undertaken at community level and included government staff, community workers and volunteers. MICAH provided nutrition and health training in addition to management training for village health committees who passed on knowledge and skills in their communities, and managed the revolving funds.

Programme successes

The programme was evaluated by comparing the results of cross-sectional cluster surveys carried out at baseline in 1996 and completion in 2004. In Senegal, the results focus on surveys conducted in 2003 and 2006 in a new area. There was a dramatic reduction in the level of anaemia in all four countries, ranging from 13 to 44 per cent. Furthermore, reductions in anaemia were greater in all MICAH communities, when compared to non-targeted children, except in Tanzania.

Mapereka drama, Malawi
World Vision 2004



1 Anaemia results in this article refer to the four countries where anaemia was addressed (Ghana, Malawi, Tanzania and Senegal). Other results are reported for all five MICAH countries, including Ethiopia.

There was a dramatic reduction in the level of anaemia in all four countries, ranging from 13 to 44 per cent



Community health worker, Malawi
World Vision 2004

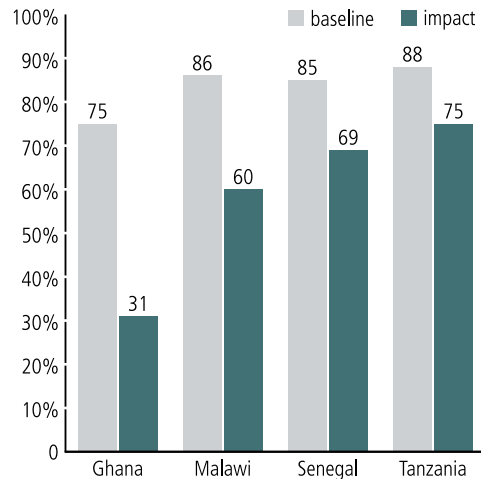
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Reduction in anaemia, child 6–59 months



Since 1996, the number of MICAH households raising small animals ranges between 40 to 95 per cent (depending on the country). MICAH households were more likely to consume their small animals, poultry and eggs than non-MICAH households. On the other hand, households were less likely to eat their goat meat and when it was consumed, it was less likely to be given to women and children. From 20 to 55 per cent of households maintain gardens and 37 to 76 per cent of households have fruit trees. The prevalence of children consuming micronutrient-rich foods increased by 30 per cent across all countries.

The general nutrition status of children improved in MICAH areas. The decrease in stunting, a measure of chronic malnutrition (short stature for age), in children aged 6 to 59 months of age, ranged from 4 to 23 per cent across all countries. Again, the changes were greater in MICAH areas compared to non-MICAH areas.

With community education, prevention and treatment of disease was improved. The distribution of ITNs contributed to the decrease of malaria by at least half in four of the five countries. Reductions in Ghana and Tanzania were more than half of what was observed in the comparative population, with no significant differences in Malawi and Senegal.

Challenges and lessons learnt

Although all five countries started out with the same basic programme framework, the activities were modified for each specific country context.

In addition, the programme faced a range of challenges including staff turnover, lengthy lead time to establish and manage the revolving funds as well as external problems.

Ongoing monitoring was needed to ensure that drugs and record books were properly maintained. Monitoring was also important to ensure that proper care was provided to the animals. In one area, disease wiped out the initial stock within a village, and the fund had to be restarted. This lesson was disseminated quickly to ensure that the problem did not recur. Climate had an impact on the choice of animals; in some villages it was too hot for rabbits so other small animals were introduced instead. Pests such as ants were a problem with the rabbits so hutches were modified to eliminate this problem. An emergency in 2001 to 2002 in Malawi forced the target communities to consume all their animals, thus restocking the revolving funds was necessary.

With the ITN revolving fund, some people paid in instalments; this required additional care with record-keeping. These examples underline the importance of programme flexibility to meet challenges as they arise.

Conclusions

Activities should be integrated within existing structures and services, and implemented in partnership with relevant government ministries, community leaders and other appropriate agencies and partners. Dietary diversification, particularly the promotion of animal source foods, is a feasible strategy to improve intake and absorption of dietary iron, and should be prioritised in integrated anaemia control programmes.

Among MICAH households, revolving funds have increased access to animal and vegetable source foods, and malaria prevention and treatment. The integrated MICAH programme shows the potential to improve the micronutrient status of children by increasing access to animal and vegetable source foods, encouraging breastfeeding and preventing malaria. These community-based initiatives should be included in an integrated approach to address anaemia and improve nutrition.

Sprinkles

Home-based fortification in Mongolia



By sprinkling a multi-micronutrient powder on the traditional food for children, and combining this intervention with nutrition education, anaemia levels were successfully decreased in Mongolia.

Mongolia is a large landlocked country in central Asia. Half the total population of 2.8 million inhabitants are either nomads or living in rural areas. Mongolia is characterized by harsh climatic conditions with temperatures ranging from -40°C to +40°C. Economic constraints, combined with traditional practices, challenge household nutrition. Nutrition and food security in the country has been further jeopardized by several years of natural disasters such as plagues of locusts and *dzud* (harsh winters often following a drought). These factors contribute to the persistence of malnutrition including micronutrient deficiency.

Anaemia and rickets are significant public health problems in Mongolia, affecting 42 per cent and 33 per cent of children less than 5 years of age respectively.¹ Iron deficiency has been identified as a major contributor to anaemia among this age group. The purpose of this article is to share some lessons learned from home-based fortification using Sprinkles implemented as part of an integrated nutrition programme by World Vision Mongolia.

The Sprinkles programme

In order to improve the nutritional status of Mongolian children and to build community and Ministry of Health capacity to improve child nutrition, World Vision designed an integrated nutrition programme in two regions of the country (Regions 1 and 2), which included the following interventions:

- home-based fortification using Sprinkles for children 6–35 months of age

- iron and vitamin D supplementation for the treatment of anaemia and rickets in children 36–59 months of age
- iron/folic acid supplementation to pregnant and lactating women
- social marketing
- community-based nutrition education
- capacity building of medical personnel
- advocacy

The programme started in 2000 in six World Vision development programme areas and was expanded in 2001 to include a further three development programme areas. Overall, the programme targeted 14,780 children aged 6–59 months, 1,250 pregnant women and 4,370 lactating women.

Development of Sprinkles

The Hospital for Sick Children (Sick Kids) in Toronto developed Sprinkles. It is a tasteless, colourless, multiple-micronutrient food fortificant, packaged in single-dose sachets, used at home to improve the micronutrient nutritional value of any traditionally cooked complementary food.³ The Sprinkles intervention has many advantages (see table).

Programme strategy

The traditional complementary foods given to children in Mongolia are primarily flour or rice-based porridges made with water and occasionally milk, sugar and butter. These foods are of low nutrient density, which contribute to anaemia.¹ The programme promoted home-based fortification of these complementary foods through the addition of Sprinkles to target children 6–35 months of age.

Children under five 2000–04

| | |
|-------------|-----|
| Underweight | 28% |
| Wasting | 7% |
| Stunting | 32% |

UNICEF Global database on child malnutrition

Sprinkles can provide the daily recommended micronutrient intake for a child



Girl with Sprinkles sachet

Philip Maher, 2003



Sprinkles are added directly to the foods of young children

Philip Maher, 2003

Sprinkles were distributed by community nutrition workers on a monthly or bi-monthly basis to the homes of beneficiaries. Caregivers were instructed to mix one sachet of sprinkles daily into the child's meal immediately after cooking and to keep the empty packets after use. Caregivers were provided with a days-of-the-week tool to help them remember to give their child the Sprinkles.

Prior to beginning the programme, focus group discussions were held with mothers and medical doctors to develop ways of increasing the acceptability of Sprinkles. As a result, it was suggested that printing the instructions and

Advantages of Sprinkles

- Sprinkles can provide the recommended nutrient intake of micronutrients for a child.
- Aside from iron, essential micronutrients such as vitamins A, C and D, folic acid, iodine and zinc can be added to the sachets.
- Lipid encapsulation of the iron prevents its interaction with food. This reduces changes in the taste, colour and texture of food, and gastrointestinal discomfort.
- The sachets are easy to use and convenient. They don't require special measuring utensils or literacy to use.
- Sprinkles can be mixed with home-made foods.
- Sprinkles are a food-based rather than a medical intervention.
- The potential for overdose is unlikely. An infant would need to consume many packages (approximately 20) to reach toxicity levels.
- The sachets are lightweight and thus are simple to store, transport and distribute.
- Sprinkles have a long shelf-life, even in hot or humid conditions (two years).
- The cost of Sprinkles is not excessive (0.015 to 0.035 US\$ per sachet). The packaging of Sprinkles is attractive.

Standard guidelines for using Sprinkles

Tear open the top of the package



Pour the entire contents of the package into any semi-liquid food after the food has been cooked and is at a temperature acceptable to eat



Mix Sprinkles with an amount of food that the child can consume at a single meal



Mix the food well after you have added the package of Sprinkles

Give no more than one full package per day at any mealtime



Do not share the food to which Sprinkles were added with other household members since the amount of minerals and vitamins in a single package of Sprinkles is just right amount for one child.



The food mixed with Sprinkles should be eaten within 30 minutes because the vitamins and minerals in the Sprinkles will cause the food to noticeably darken.



ingredients in Mongolian and stamping the expiration date on the packet would increase confidence in the product. A local artist was hired to design the artwork on the packet.

Programme evaluation

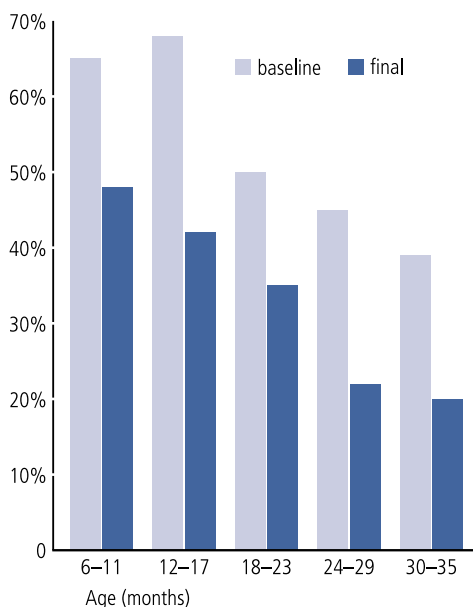
The effectiveness of the nutrition programme was evaluated by comparing indicators from baseline and final household surveys (a two to three-year interval). The surveys included a household questionnaire, assessments of anthropometric measures and clinical indicators for anaemia (haemoglobin concentration measured by Hemocue) and vitamin D deficiency.

The prevalence of anaemia in children 6–35 months of age was significantly reduced from 55 to 33 per cent from baseline to final. Significant

reductions were also observed in each age sub-group (see figure). In addition to the increased intake of iron through sprinkles, the decrease in anaemia among children under three years of age can be attributed to increased variety and quantity of complementary food offered and also improved breastfeeding practices as a result of nutrition education. Rates of exclusive breastfeeding to six months of age increased from 16 to 40 per cent in Region 1 and from 19 to 44 per cent in Region 2.

Significant reductions in anaemia were also observed among children 36 to 59 months of age as prevalence decreased from 29 to 13 per cent in combined programme regions. There are various contributors to the decrease in anaemia observed in this age group. Prevention probably played a key role, as children in this age group would have received sprinkles when they were 6–35 months of age. Also nutrition education for mothers on exclusive breastfeeding and the promotion of iron-rich foods may have resulted in changed behaviours that would affect overall anaemia status. In addition, iron syrup was provided for the treatment of anaemic children.

Prevalence of anaemia in children 6–35 months of age, at baseline and final by age categories



There was a high coverage and good acceptability of Sprinkles. A total of 88 per cent of households with children 6–35 months reported using sprinkles

Sprinkles Formulation for Mongolia⁴

- Vitamin D 400 IU
- Vitamin A 600 IU
- Vitamin C 50 mg
- Folic Acid 150 ug
- Iron 40 mg
- Zinc 10 mg



for a period of four months or more, suggesting good acceptability of the product.

Sustainability of the programme

The Sprinkles programme is ongoing in Mongolia. Though no large scale evaluation has been done since 2003, regular monitoring indicates successful implementation. The families continue to be provided with the Sprinkles sachets through the programme, however, and the manufacture of Sprinkles is not local. This raises questions about longer-term sustainability. Focus group discussions have been held to assess whether or not caregivers would be willing to purchase the sprinkles themselves. The feedback from these discussions has indicated that the majority of families would be willing to purchase the Sprinkles as they perceive the benefits to their child. Furthermore, support to local vendors to set up a small business for the sale of Sprinkles is being considered. This would help to ensure that Sprinkles are available in remote areas.

Conclusions

Integrated programming, including home-based fortification using Sprinkles, is a successful approach for reducing anaemia among Mongolian children under five years of age. Sprinkles were widely accepted and the use of a Mongolian motif and instructions on the packages was noted as an important aspect of product acceptance. A further benefit to the home-based fortification approach was that this strategy did not require the introduction of new foods, but effectively added nutrient value to the commonly used complementary foods in Mongolia.

- 1 Report on 1999 2nd National Child & Nutrition Survey. Nutrition Research Center and UNICEF. Ulaanbaatar, 2000.
- 2 Draft report of study on anemia causality in Mongolian children. Nutrition Research Center and World Vision Mongolia, Ulaanbaatar, 2004.
- 3 Micronutrient Sprinkles to control childhood anaemia. Zlotkin SH et al. *PLoS Med* 2(1): e1 DOI. 2005
- 4 Subsequent programmes use a reformulated Sprinkles with 12.5 mg of iron per sachet to reflect more recent studies on the iron absorption from Sprinkles.



Bus advertisements were used to promote iron supplementation to pregnant women
WVMongolia

Colleen Emery

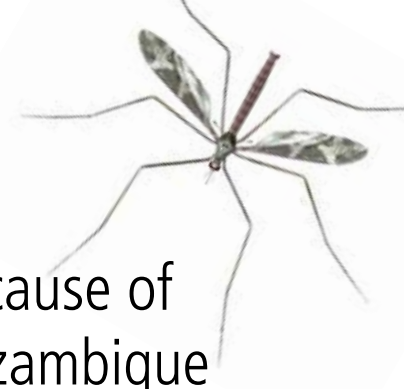
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Once bitten...

Malaria is a more important cause of anaemia than poor diet in Mozambique

Children under five 2000–04

| | |
|-------------|-----|
| Underweight | 24% |
| Wasting | 4% |
| Stunting | 41% |

UNICEF Global database on child malnutrition

There is a good correlation between moderate and severe anaemia and the presence of malaria infection

1 Randomized placebo-controlled trial of iron supplementation and malaria chemoprophylaxis for prevention of severe anemia and malaria in Tanzanian infants. Menendez C et al. *Lancet* 350: 844–850. 1997.

2 The Africa Malaria Report 2003. WHO and UNICEF. 2003.

3 The ears of the hippopotamus: manifestations, determinants, and estimates of the malaria burden. Breman JG. *Am J Trop Med & Hyg* 64, 1–11. 2001.

4 Children's anemia levels in West Africa: a good proxy for malaria morbidity? Greenwell F and Neuman M. 2006.

In developed countries iron deficiency is the most common cause of anaemia. In countries where malaria is highly endemic, particularly in sub-Saharan Africa, malaria is the major contributor.¹

Human malaria, transmitted by female Anopheles mosquitoes, is a protozoan disease typically caused by one of four members of the genus *Plasmodium*: *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*. Malaria is one of the leading causes of morbidity and mortality of infectious disease origin throughout the world, resulting in 300–500 million clinical cases per annum and approximately 2 million deaths.² Over 90 per cent of malaria cases occur in sub-Saharan Africa, mainly in children under five years of age and in pregnant women. These groups are particularly vulnerable due to their lack of, or reduced immunity making them more susceptible to infection. Malaria results not only in lost life and productivity due to illness and premature death, but also hampers children's schooling and social development through both absenteeism and permanent neurological damage, which is associated with severe episodes of the disease.

Infection with *P. falciparum* and the ensuing disease of malarial anaemia are responsible for the majority of malaria-related morbidity and mortality in African children. Malaria causes anaemia both by rupturing red blood cells and by suppressing the production of new red blood cells. When haemoglobin levels become profoundly reduced, life-threatening severe malarial anaemia can result. Although several definitions of severe malarial anaemia exist, in practical terms, severe malarial anaemia is defined as haemoglobin levels less than 5g/dl in the presence of malaria infection of any density. Therefore, when measuring malarial

anaemia, it is necessary to measure not only haemoglobin level but also parasitemia.

In the last five years there has been an increasing move to 'roll back malaria' by 2010 by halving malaria morbidity and mortality. The move was initiated with the signing of the *Abuja Declaration* by the Head of African States in 2002. With this political commitment, more resources have become available through the Global Fund to Fight Aids, Tuberculosis and Malaria, the President Bush Malaria Initiative, the World Bank and bilateral organizations, and more recently private-public partnerships. However, with increased resources there is a need for a variety of long-term monitoring strategies to evaluate the progress of malaria control interventions in reducing malaria morbidity and mortality.

In Africa, routine health information is normally imprecise. Diagnosis is often based on clinical symptoms alone, providing an over-estimate of the disease burden. However, due to poor access to health facilities only a small fraction of people with symptoms will visit health centres and the majority of deaths attributable to malaria occur at home so they are never officially registered.³ In view of these data inadequacies, countries are moving towards the use of population-based studies to monitor changes in the malaria situation; haemoglobin is one indicator.

Haemoglobin has been proposed as a fitting indicator for tracking the burden of malaria for several reasons.⁴ The first reason is that almost all children with malaria will inevitably develop

anaemia, although not all anaemia is caused by malaria (or malaria alone). The second reason is that haemoglobin measures are becoming more widely available from population-based surveys providing information on the socioeconomic, residential, and demographic differences in anaemia levels. Lastly, the proportion of young children with severe anaemia, is an easier measure to collect, than the proportion who have died from anaemia.⁵

In Mozambique, malaria is a major public health problem accounting for 40 per cent of all outpatient consultations and 40 per cent of all admissions to paediatric wards. In addition, anaemia accounts for 7.6 per cent of all deaths in rural hospitals.

The main malaria control interventions currently recommended by WHO and implemented in Mozambique are:

- Long lasting insecticide treated bed nets
- Indoor residual spraying
- Intermittent preventative treatment particularly for pregnant women
- Treatment using artemisinin-based combination therapies

The main indicator to monitor progress is the reduction in prevalence levels of malaria in children below the age of 15 years. Haemoglobin levels have also been monitored over time in the same population and more recently a health facility study is proposed to look at haemoglobin levels in pregnant women with access to intermittent presumptive treatment.

Haemoglobin levels are measured using portable hemocues. The presence of malaria parasitemia is confirmed using rapid diagnostic tests (RDTs) that detect only *P.falciparum*. Both samples are obtained through a finger prick. Presence of anaemia is defined as haemoglobin of less than 11g/dl in children of six months to six years and 12g/dl in children of 7–14 years. Anaemia levels are further defined as mild (8.1–12g/dl), moderate (5.1–8g/dl) and severe (< 5 g/dl).

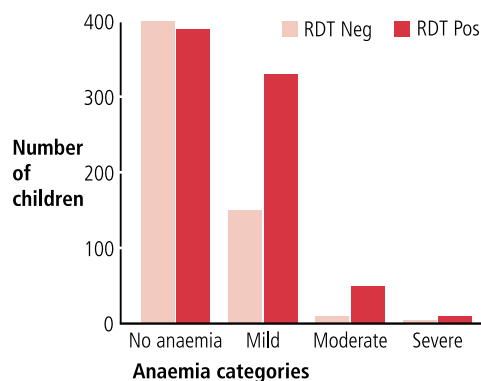
In a pre-malaria control intervention survey in one district in Southern Mozambique in 2005, results showed that malaria infection was present in 56 per cent of this population (1,441 children



sampled) while anaemia was present in 33 per cent of children aged six months to six years and 21 per cent aged 7 to 14 years. Anaemia prevalence was found to be extremely high with 38.6 per cent of the 1,441 children sampled having mild, 4.3 per cent moderate and 0.5 per cent severe anaemia.

When presence of malaria infection is plotted against the different categories of anaemia (see figure) it can be seen that there is a good correlation between moderate and severe anaemia and the presence of malaria infection. Follow-up studies post-intervention will be carried out to determine not only if the prevalence of malaria has been reduced but also whether anaemia, particularly severe anaemia, attributed to malaria has been reduced.

Children 6m–15 years with anaemia, with and without malaria



The results above support the fact that anaemia is a good indicator for measuring the impact of malaria control interventions. Studies have shown that increased intake of micronutrients can reduce stunting and nutritional anaemia.⁶ But in malaria-endemic areas, it is malaria that is the main contributor to anaemia and not dietary factors.

Population-based survey blood collection, Maputo Province
Lumbombo Spatial Development Initiative 2003

5 Characteristics of severe anaemia and its association with malaria in young children of the Kassena-Nankana district of northern Ghana. Owusu-Agyei S et al. *S Am J Trop Med & Hyg* 67(4): 371–377. 2002.

6 Stunting may determine the severity of malaria-associated anemia in African children. Verhoef H et al. *Pediatrics* 110(4) pp. 48. 2002.

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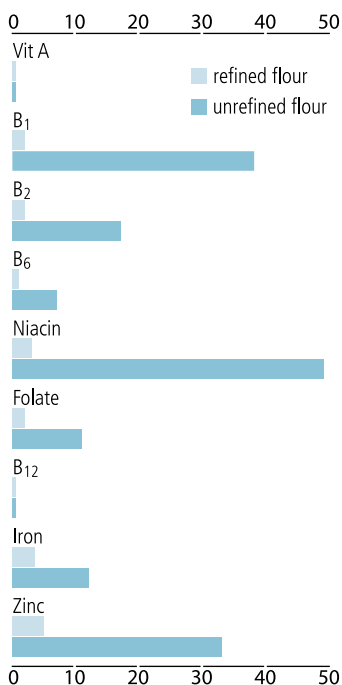
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Combining strategies

A wise combination of **several strategies** is needed to prevent nutritional anaemia

Promote better nutrition through providing other micronutrients in addition to iron and folic acid



Comparative nutritional value of whole and refined wheat flour

Percentage estimated average requirement for women of reproductive age in 100 kcal

Prevention of nutritional anaemia is best addressed through providing multi-micronutrients and requires a range of strategies. Some strategies are better suited to some population groups.

A balanced diet should contain appropriate amounts of milk, eggs, meat, fish and poultry, nuts and seeds, fresh fruits and vegetables. Regrettably, many societies have lost variety in their diet.

Poor rural communities obtain most of their energy from cereals which, if not refined, provide large amounts of vitamins B₁ and niacin and, depending on the type, also good quantities of vitamins B₂, B₆ and B₉ (folate). In general, cereals are poor in bio-available forms of minerals especially iron and calcium. In these communities, cereals are usually complemented with grains and legumes (good sources of B₂ and folate), fruits and vegetables (good sources of folate, and vitamins C and E). The inadequate intake of animal foods, however, results in micronutrient deficiencies due to lack of iron, zinc and calcium, and vitamins B₁₂, A and D (though the latter can be synthesized if the skin has sufficient exposure to sunlight).

The limiting factor for vitamin A and minerals is not so much inadequate intake but inadequate bioavailability, as the human intestine is unable to extract these micronutrients from the vegetables that contain them. Fermentation is one way to replace the role of the herbivorous animals in the food chain and increase bioavailability, but fermentation is rarely used.

Urban communities in developing and developed countries spend less time out in the sun, eat less fresh fruit and vegetables, and eat more refined cereal flour, sugar and vegetable fat. These are good sources of energy but poor sources of micronutrients. In better-off groups, consumption

of animal foods may be high. Therefore, rich urban populations may suffer from deficiencies of vitamins C and E, and complex B, including folate, while poor urban groups may lack both vitamins and minerals.

The importance of micronutrients

Micronutrient deficiencies cause a range of diseases including nutritional anaemia. Nutritional anaemia is very prevalent worldwide, and mainly affects women of reproductive age, adolescents and infants, because of their high physiological need for micronutrients. Supplementation with iron and folic acid (a synthetic form of folate) has been used for many years with some success.

It should be noted, however, that additional iron and folic acid will not work if other micronutrients are also insufficient in the diet. This is because iron and folate do not act in isolation but in combination with other substances in the human body. The correction of anaemia involves the synthesis of haemoglobin and red blood cells.

These processes require vitamins A, B₂, B₆, B₁₂ and niacin in addition to iron and folate. Vitamin E is needed to protect cell membranes against oxidative stress and vitamin C improves the intestinal absorption of iron. Other micronutrients such as vitamin B₁, zinc, calcium and trace elements are also needed to keep the human metabolism working properly. Thus, the correction of anaemia, like other nutrition-associated illnesses, requires a good nutrient balance.

Food fortification

Food fortification is the addition of micronutrients

to an edible product (food or condiments) regardless of the original nutritional composition of that product. The classic example of food fortification is the addition of iodine to salt, which has become the main source of this mineral in the human diet. Vitamin A has been incorporated into oil, fats and sugar. Cereal flour is a suitable vehicle for many micronutrients and fortification can be done at a relatively low cost. Fortified flour is an ideal way to help to prevent nutritional anaemia.

The consumption of 89 grams of whole wheat flour gives around 100 kcals of energy, and provides relatively large amounts of B₁, niacin and zinc, but low amounts of iron and folate (see graph on the left). After milling, the starch is separated from the bran resulting in refined flour. The energy density is increased by 3.3 times in refined flour but the micronutrient content is greatly reduced. Only 27 grams of flour contains 100 kcals of energy, and very low levels of all micronutrients. Thus, foods that are industrially produced can promote obesity but impair nutrition. Neither whole nor refined flour contains vitamin A (as retinol) or vitamin B₁₂ because these micronutrients do not exist in plants.

Fortification restores the nutritional content of cereals lost during milling. Furthermore, nutrients that are not naturally present, such as vitamins A and B₁₂, can be incorporated (see graph on the right). Fortified refined wheat flour is therefore an excellent source of many micronutrients. The iron content is lower because flour is not easily fortified with iron. If the consumption of flour is low, alternative interventions will have to be considered.

Whole wheat flour can also be fortified, but because of the presence of elements that prevent iron absorption, iron availability is limited in comparison with refined flour. This is true even when the most bio-available sources of iron, such as NaFeEDTA, are used.

Fortified complementary foods

Children usually benefit less from fortification of staples and condiments than adults because of their lower food consumption. Thus, specially formulated foods need to be considered for children. These foods should contain low levels of

iron absorption inhibitors as the micronutrient and energy density of food is much more important than the level of fibre in the diet for children.

Fortified complementary foods for children can be made from natural ingredients (mainly from animal origin). If they are industrially produced, it should be by well managed and centralized factories to ensure hygiene and safety standards.

Dietary supplements

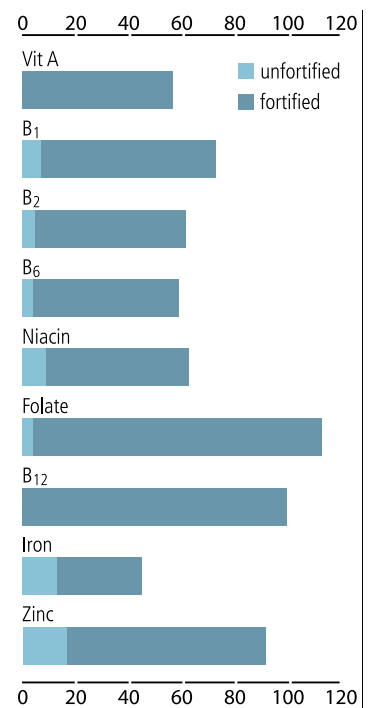
In developing countries, a large proportion of the population at risk of nutritional deficiencies may not have access to industrially-produced foods, and hence are excluded from the benefits of food fortification. In these circumstances, dietary supplements in addition to an improved diet can be considered.

The effectiveness of using dietary supplements in the form of tablets has not been successful to date. Recent studies, however, suggest that supplements that are added in powder form (such as Sprinkles) are more acceptable; a strategy called home fortification. The limitations of home fortification are mainly operational in nature, such as how to create a reliable distribution mechanism and how to cover the cost of the product.

Conclusions

Providing iron and folic acid to prevent nutritional anaemia is only useful if these are the nutrients most deficient in the diet. A better approach is to promote better nutrition through providing other micronutrients in addition to iron and folic acid. The population at highest risk of micronutrient deficiencies are the urban poor. Because of their dependence on industrially-manufactured foods, however, they can potentially benefit from food fortification.

Complementing the diet of rural populations in developing countries remains a big challenge. Home fortification using dietary supplements is one way to address this problem in both adults and children. Prevention of nutritional anaemia requires the wise combination of several strategies; this is a complex dietary, environmental and physiological problem that cannot be solved with simplistic approaches.



Supply of micronutrients in 100 g of fortified refined wheat flour

Percentage estimated average requirement for women of reproductive age

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Suck it and see

Fortified **lozenges** delivering multiple micronutrients to the community in India

Children under five 2000–04

| | |
|-------------|-----|
| Underweight | 47% |
| Wasting | 16% |
| Stunting | 46% |

UNICEF Global database on child malnutrition



Child narrating how much she likes nutri-candy (poster behind) in Bihar

Tripti Pant Joshi 2006

An innovative way of providing multiple micronutrients through lozenges, called nutri-candy is being tried out in India. By sucking just one lozenge a day, an Indian child will receive half of his or her daily needs for four micronutrients including iron.

The prevalence of micronutrient deficiencies among children and women of reproductive age in India is among the highest in the world. The prevalence of iron deficiency anaemia (IDA) among preschool children is over 75 per cent. Over half (52 per cent) of women aged 15 to 49 years have some degree of anaemia and in pregnant women, it is even higher at 87 per cent.

Fortification of commonly eaten foods is considered one of the best approaches for combating micronutrient deficiencies. A variety of centrally processed staple foods, such as flour, milk, edible fats and oils, have been used as vehicles for iron and vitamin A fortification in many countries. However, in India, a large percentage of the population does not consume centrally processed foods. To address the needs of such populations, the Micronutrient Initiative has developed an innovative product in the form of a fortified lozenge popularly called nutri-candy.

Nutri-candy is a hard boiled sugar-based lozenge with added orange colour and flavour.

Each lozenge provides about 50 per cent of the recommended daily allowances (RDA) for four micronutrients, vitamin A, vitamin C, folic acid and iron, for a child in India.

Nutritional content of nutri-candy

| Nutrients | Levels per 3 gram lozenge |
|------------|---------------------------|
| Vitamin A | 500 IU |
| Vitamin C | 10 mg |
| Folic acid | 50 mcg |
| Iron | 7 mg |

Pilot activities

The Government of India runs one of the largest supplementary feeding programmes in the world through the Integrated Child Development Services programme. It targets children up to six years of age, pregnant and lactating women, and adolescent girls through a network of village level centres. The supplementary food provided at the centres contains calories and protein but insufficient micronutrients. As a pilot, the fortified lozenges were introduced through the supplementary feeding programme in one district, Howrah, in the state of West Bengal.

The aim of the pilot project was not only to improve the micronutrient status of children and women but also to improve the attendance of beneficiaries at the centres. Approximately 2,500 supplementary nutrition centres distributed a lozenge daily for 18 months to each beneficiary reaching approximately 120,000 children, 175,000 adolescent girls and 25,000 pregnant and lactating women.

A pre- and post effectiveness study under programmatic conditions, with control and experimental groups was conducted for children aged two to five years. The results showed a reduction of 15 per cent in the prevalence of anaemia and 11 per cent in vitamin A deficiency over the 18 month period. In addition, compliance was very high (more than 90 per cent) and a substantial increase (54 per cent) in the attendance of pre-school children at the centres was observed.

A randomised double blind placebo efficacy

study was undertaken under controlled conditions in a district of another state, Haryana, where pre-school children received fortified lozenges for a period of 12 weeks under supervision. The reduction in anaemia in this study was much higher at 50 per cent, largely because the distribution of the lozenge was more closely supervised.

Scaling up

Based on the success of the fortified lozenges under controlled as well as programmatic conditions, the pilot project in the Howrah district was scaled up to other districts in West Bengal. Other states in India have also accepted the fortified lozenges as a complement to the supplementary food provided at the supplementary nutrition centres.

Today, more than five million beneficiaries in four states receive a fortified lozenge every day for 250 to 300 days a year at a cost of less than one-fifth of a rupee per day per beneficiary or approximately US\$ 1.33 per beneficiary per year inclusive of transportation and training.

Advantages and disadvantages

The fortified lozenges have several advantages. They can be targeted to the desired age group with ease and since they are well accepted, the compliance rate is high. The lozenges can be manufactured by existing sweet manufacturers with very little additional investment or effort and hence can be made available to large segments of the population at low cost. They can be easily introduced into

existing programmes, replicated and scaled up.

Where possible, nutri-candy should be part of a larger community based programme rather than provided as a stand-alone intervention. However, where other programmes do not exist, it can be given under close supervision and combined with food based activities to make it more effective.

Care is needed to ensure that the micronutrient content of the lozenges is maintained at around the required level to meet 50 per cent of the RDAs. The number of lozenges a beneficiary ought to consume per day should be specified and monitored. Storage conditions (avoiding exposure to direct sunlight or humidity) are also an important factor in maintaining the quality of the product.

The lozenges do contain sugar and can potentially contribute towards dental caries. The total quantity of sugar in each lozenge, however, is about 2.8 grams. Even so, it is important that children only receive one lozenge per day with proper messages on oral hygiene.

Conclusion

In the absence of a readily available and centrally processed staple food, fortified lozenges are an acceptable and cost effective alternative for providing multiple micronutrients, especially iron where compliance with supplements is a big problem due to side effects. Because of its high level of acceptability, it can be readily integrated within a community-based programme.



Nutri-candy

Micronutrient Initiative 2006

By sucking just one lozenge a day, an Indian child will receive half of his or her daily needs for four micronutrients including iron.



Children receiving nutri-candies

Micronutrient Initiative 2006



Children receiving nutri-candy in supplementary nutrition centre Bihar

Amit Singh 2006

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Food-based strategies are essential to combat iron deficiency anaemia

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Food-based strategies aim to improve nutrition by increasing the availability and consumption of a nutritionally adequate micronutrient-rich diet from a variety of available foods. Such strategies are effective in combating iron deficiency anaemia (IDA), multiple nutrient deficiencies and other forms of malnutrition in a sustainable manner. They need to be adopted as part of a comprehensive approach as a matter of priority.

The global scale of IDA and the damaging effect on individuals and society, require the urgent adoption of known and effective measures. Nutritionists assume that all nutrients can be obtained from a varied and balanced diet and that if people had access to a sufficient quantity and variety of foods, nutritional needs would be met. But despite increases in the availability of a wide variety of foods in almost every country in the world, IDA and other micronutrient deficiencies remain high. If the most common cause of iron deficiency is nutritional iron deficiency, why has improved average food supplies not resulted in adequate vitamin and mineral intakes? Does this imply that the normal diet cannot cover physiologic iron requirements?

There are a number of factors that explain this apparent paradox. Widespread poverty results in low food intake and poor quality, monotonous diets low in micronutrient content. Lack of understanding about the value of a varied diet and the importance of foods rich in micronutrients and the role of dietary inhibitors and enhancers that affect iron absorption play a role. Illness and infections such as malaria, tuberculosis and HIV/AIDS are also contributing factors.

To address these underlying causes, FAO calls for actions promoting an increase in the supply, access and consumption of an adequate quantity, quality and variety of foods for all population groups, actions which are in keeping with the 'Right to Food'.

Increasing food consumption and improving and diversifying diets present the only sustainable and long term solution for overcoming iron deficiency anaemia and other micronutrient deficiencies. This is because diets deficient in one micronutrient are likely to be deficient in a number of other micronutrients, and to be poor sources of fat and protein that aid absorption of nutrients. Consequently FAO is committed to placing food-based strategies high on the development policy agenda.

There are feasible and practical actions to increase the consumption and bio-availability of iron.

- Increase overall food intakes by increasing food production, availability, processing, preservation and consumption.
- Diversify diets by increasing the consumption of micronutrient-rich sources of foods high in bio-available iron including animal products, legumes, and vegetables.
- Improve dietary habits to reduce the impact of iron absorption inhibitors such as phytates and increase the impact of enhancers such as vitamin C.
- Improve processing, preservation and preparation practices that reduce losses and retain micronutrient availability such as the use of iron cooking pots and improved drying techniques.
- Increase financial investments in food-based initiatives.
- Educate consumers by designing communication strategies to promote behavioural change.
- Focus on food quality and safety issues emphasizing the importance of public health measures to reduce infections and the potential of fruit and vegetables as high value income generation commodities.
- Explore options for home fortification of complementary foods.

Fortification and supplementation programmes are considered attractive because of their apparent simplicity and cost-effectiveness. In practice they have often proved difficult to manage, more costly than expected and less effective than promised. Their effectiveness can be raised, however, if the quality of the overall diet is also improved.

Food-based strategies are preventive, cost-effective and sustainable. They encourage popular demand for safe, wholesome food and foster the development of sustainable agriculture that has positive knock-on effects for the rural economy. Their success needs strong community-level commitment and political support and well financed food-friendly based initiatives. Adopting food-based strategies helps to ensure the right mix of dietary diversification, food fortification, supplementation and public health measures to combat iron deficiency. A balanced, more comprehensive approach has the greatest potential for overcoming iron and other micronutrient deficiencies in the long-term.

Opinions expressed in Viewpoint are solely the author's and do not necessarily represent those of the editors of nutrition.

The basics

Useful information about anaemia and iron deficiency

How anaemia occurs

Anaemia occurs when the concentration of haemoglobin in blood falls below a threshold that is associated with good health. Haemoglobin is the red pigment in blood that carries oxygen from the lungs to all tissues of the body, and returns carbon dioxide to be exhaled. When the concentration of haemoglobin is low, the blood cannot carry enough oxygen to meet the needs of tissues. To compensate, an anaemic person breathes faster to try and get more oxygen and, as the carbon dioxide builds up in tissues, the muscles and brain get tired. Breathlessness, tiredness and lethargy are all commonly reported symptoms of anaemia.

WHO and UNICEF have set thresholds below which a person is defined as anaemic. Anyone with a haemoglobin concentration less than 80 g/L is classified as severely anaemic.

| Thresholds for anaemia | | | |
|------------------------|-----------------------|-------------------|------------------------|
| Age range | Sex group | Haemoglobin (g/L) | Packed cell Volume (%) |
| 6–59 months | Both sexes | 110 | 33 |
| 5–11 years | Both sexes | 115 | 34 |
| 12–15 years | Boys | 120 | 36 |
| 12–15 years | Girls | 120 | 36 |
| 16+ years | Males | 130 | 39 |
| 16+ years | Females, non-pregnant | 120 | 36 |
| | Females, pregnant | 110 | 33 |

Haemoglobin is contained in red blood corpuscles (RBCs), which are pumped around the body by the heart in fluid called plasma. RBCs in a healthy person typically have a life-span of about 120 days, which means that some 0.8 per cent of all corpuscles need to be replaced each day. The old RBCs are destroyed by the spleen, where the iron is carefully recovered and passed to the bone marrow, the site where millions of new RBCs are made each day. This is a highly active process that requires energy and protein, as well several key micronutrients including vitamin A, vitamin B₁₂, folate, and iron.

Anaemia can occur for three main reasons:

- the bone marrow does not make enough RBCs each day to replace daily losses;
- not enough iron is available from the diet to make haemoglobin;
- there are problems with making haemoglobin in the bone marrow.

There are many reasons why bone marrow does not make enough RBCs:

- a lack of nutrients needed to make blood corpuscles, such as protein, vitamin B₁₂, folate, or vitamin A;
- a genetic defect in producing RBCs, such as thalassaemia;
- RBCs have a shorter life span than usual, because of a genetic defect, glucose-6-phosphate deficiency, or because of a chronic disease such as osteomyelitis or arthritis;
- excessive numbers of RBCs are lost during monthly menstrual bleeding or during child birth;
- RBCs are destroyed in large numbers by malaria;
- RBCs are lost due to internal bleeding caused by worm infections such as hookworm or schistosomes, or during bacterial or amoebic dysentery.

Any loss of RBCs means that iron is lost in haemoglobin, and needs to be replaced from iron stores or, if they have been used up, from diet.

There are a number of different reasons why not enough iron is obtained from the diet:

- the normal 1 mg of iron lost from the body each day by an adult is greater than the amount absorbed from the diet;
- there is very little iron in the diet in the first place;
- the iron in the diet is not available for absorption, especially if it is present in plant foods;
- iron is poorly absorbed across the wall of the intestine;

Finally, there may be problems in actually making haemoglobin in the bone marrow due to a lack of micronutrients or genetic defects.

Anaemia during pregnancy

The anaemia that occurs during pregnancy is different, and happens for three main reasons:

- the volume of the plasma expands by about 50 per cent while the volume of RBCs only increases by about 20–25 per cent, so there is a relative dilution of haemoglobin in the blood;

- increased production of RBCs, which requires extra folate and vitamin B₁₂, among other nutrients;
- greater needs for iron both to make haemoglobin for the mother and her baby, and to lay down as iron stores in the foetus.

It is estimated that an extra 800–1000 mg of iron is needed during pregnancy, mostly during the last trimester. If a half of the iron a woman needs during pregnancy is provided by tablets of ferrous sulphate, and if only 10 per cent is absorbed, then a woman needs to take one tablet a day for at least 12 weeks, so taking iron daily during the second and third trimester is very important.

Iron deficiency and iron deficiency anaemia

Iron deficiency and iron deficiency anaemia (IDA) are strongly linked, but not all anaemia is due to iron deficiency, and iron deficiency can occur without anaemia. A deficiency of iron can impair the immune system, it may affect the function of several important enzymes, and may harm the development of the brain of young children, though the evidence for this is not strong.

WHO estimates that about a half of all cases of anaemia are due to a lack of iron, mostly caused by a poor diet. The number of people who are iron deficient is about twice the number who are anaemic. So if more than 50 per cent of a population are anaemic, then nearly the total population are likely to be iron deficient.

Measuring anaemia

Anaemia is hard to identify by its clinical signs alone unless it is severe. The simplest way is to pull down the lower eyelid and look at the conjunctiva, the lining to the eye socket. If it is pale rather than pink, then the person may be anaemic. As this is a matter of judgement and experience, it is only useful to identify severe anaemia, and is not a reliable way to diagnose mild anaemia.

It is better to measure the haemoglobin concentration, which is usually expressed as grams/litre or grams/100 ml. The haemoglobin concentration can be estimated in three main ways using blood taken from a vein using a syringe or from a finger prick using a sterile lancet.

The cyanmethaemoglobin method requires the collection of blood samples that have to be transported to a laboratory. The second method uses a Hemocue® haemoglobinometer which is a portable, battery operated machine. A Hemocue® costs about US\$ 400 if from UNICEF, and each cuvette costs about US\$ 0.4–0.5. In the haemoglobin colour scale, fresh blood is dropped onto a piece of absorbent white paper, and the colour is compared with a chart. This method only correctly identifies 75–97 per cent of anaemic people.

It can be useful to examine a stained smear of blood under a microscope, because the size, shape and colour of RBCs can help to identify the type of anaemia.

Iron status can be assessed by measuring the concentration of two

blood proteins in serum or plasma: ferritin (an estimate of iron stores) and transferrin receptor (an estimate of the need for iron by tissues).

Treating anaemia and iron deficiency anaemia

Unlike vitamin A and iodine, iron cannot be given in a large single dose. Instead, it has to be trickled into the body in small amounts over a period of weeks or even months. Ideally everyone should get all the iron they need from their diet, so trying to improve the quality and quantity of the food is very important, particularly in the long term. The amount of iron in the diet is strongly correlated with the amount of food eaten each day, so improving the quantity as well as the quality of the diet is important.

One simple way to improve the quality of basic foodstuffs is to fortify commonly eaten foods with iron. The third strategy is to take iron supplements or, better still, multiple micronutrient supplements, as this would treat anaemia not due to iron deficiency as well as IDA. It is also rare to find an iron deficiency on its own – usually other micronutrients are lacking at the same time.

Finally, it is also important to treat infectious diseases that may cause blood loss, such as worm infections, or infections that destroy or damage RBCs, such as malaria.

Dietary treatment of iron deficiency and anaemia

Iron in food can be poorly absorbed from the intestine. The reasons are complicated, but depend on the molecular form of the iron, the type of food the iron is in, and whether or not the body is iron deficient.

First, iron is found in two main molecular forms. The ferrous form of the iron molecule is soluble in water, whereas the ferric form of iron is only soluble in acid solutions. Ferric iron can be converted to ferrous iron by acidic and reducing substances in the gut such as vitamin C, which helps absorption.

Second, iron is in two food types: in plant foods, mostly as inorganic iron, and in animal foods, mostly as organic iron in the haem (=heme) molecule in red meat. The inorganic iron in plant foods is poorly absorbed because it is present mostly in ferrous or ferric forms, and because it gets stuck to substances such as phytates and tannins, and cannot be absorbed. Haem iron is better absorbed than inorganic iron.

Iron is very carefully conserved by the body, and less than 1 mg is lost every day, mostly in dead cells shed from the gut and skin. As iron cannot be actively excreted, the only way to control the amount in the body is by increasing or decreasing absorption from the gut. A recently identified protein called hepcidin may be responsible for this.

What all this amounts to is that only between 5–15 per cent of iron in plant foods is typically absorbed from the small intestine and between 20–30 per cent of iron in animal foods.

- Eat animal foods such as red meat and liver together with plant foods that promote the iron absorption;

- Do not drink black tea with meals, because it contains tannins;
- Drink fruit juices or eat fruit with food, to convert ferric to ferrous iron.

Several studies have shown that using an iron cooking pot can increase iron consumption because small amounts will be dissolved in the food each time it is used.

Medical treatments for iron deficiency and anaemia

As there are so many different possible causes of anaemia it is not easy to know why the haemoglobin concentration is low without doing blood tests, so the treatment given is often presumptive. As about a half of all anaemia is due to an iron deficiency, giving iron tablets is sensible. This could be done on a mass basis when the prevalence of anaemia is more than 50 per cent, because this indicates that most people will be iron deficient. School teachers in Mali and the Philippines have been shown to be able to give a course of weekly iron supplements to their pupils for 12 weeks that can lead to an improved haemoglobin concentration. It may be more effective to give an iron tablet twice a week if it can be supervised, and deworming and vitamin A every six months.

The cheapest and most effective forms of iron used in tablets are ferrous sulphate and ferrous fumarate. A 200 mg tablet of ferrous sulphate provides about 60 mg of iron, of which perhaps 6 mg (10 per cent) will be absorbed. As this is only 30 per cent of the iron required each day by a non-pregnant woman eating a good diet and 10 per cent on a poor diet, treating anaemia using iron pills is not quick.

As the body cannot excrete iron, taking too much can be toxic. There is also some concern that, if a young child who is not iron deficient is given ferrous sulphate tablets daily, the iron could make worse any current infectious diseases or malaria. The WHO and UNICEF have issued a statement which says that it is best to treat only anaemic children with iron, and to protect them from malaria and other infectious diseases while they are taking iron tablets.

A major problem with iron tablets is getting people to take the pills regularly. This is because iron can cause unpleasant side effects including nausea, constipation and black stools. These effects may be reduced if tablets are taken with meals, but plant foods may reduce the absorption of iron from pills.

Although deficiencies of vitamin B₁₂ tend to be uncommon in developing countries, a folate deficiency may occur, especially during pregnancy when the need for this vitamin is greater. It is sensible to give iron-folate tablets, rather than iron tablets alone.

In some countries a large proportion of anaemia may be due to vitamin A deficiency. A study of supplements of vitamin A given to schoolchildren in Tanzania reported an increase in haemoglobin

concentration in 12 weeks of 10 g/L more than untreated controls. A dose of 200,000 IU every six months is usually given to all children aged 12–59 months, and could be given to all school-age children as well, especially if vitamin A intakes are seasonal.

Treating infections

If parasitic infections such as malaria, hookworms and schistosomiasis are common, treating or trying to prevent infection is a sensible thing to do.

Giving treatment for malaria is most important in places where the disease is seasonal or occurs in epidemics because people do not have much resistance and their illness can be severe. In areas where malaria occurs all year round, the main target group for treatment is pregnant women because the parasite can cause anaemia in the mother and damage the placenta so that the baby is born underweight. Pregnant women should be given bed nets to sleep under and, after the first trimester, at least two treatments with an effective drug such as sulphadoxine/pyrimethamine or amodiaquine. These drugs may suppress the multiplication of the malaria parasite, rather than treat the disease. It is not known yet whether combinations of artemisinin and other drugs that are now recommended by the WHO to treat all cases of malaria are safe and effective to use during pregnancy. Advice should be taken on this locally.

Studies have shown that young children who sleep under a bed net at night have a higher haemoglobin concentration than children who do not. Ideally the bed net should be treated with a long-lasting insecticide to kill mosquitoes, as well as prevent them from biting.

Treating worms is an easy and inexpensive thing to do. A single dose of 400 mg of albendazole or 500 mg of mebendazole is an effective treatment for hookworms, but three daily doses may be needed to treat moderate to heavy infections with the whipworm, *Trichuris trichiura*. These drugs can be given to any person older than one year every six months in areas where more than 50 per cent of children are infected with worms. Schoolchildren should be particular targets because they tend to be most heavily infected, and treating them can reduce transmission as well.

A single dose of albendazole should be given to pregnant women after their first trimester in areas where hookworm occurs. A study in Sierra Leone showed that deworming helped to prevent a decline in haemoglobin concentration after the first trimester of pregnancy.

The drug praziquantel can be given as a single dose of 40 mg/kg of body weight to treat any of the three main species that cause schistosomiasis, also called bilharzia. Pregnant women should not be treated in their first trimester.

Resources

A selection of accessible resources, events and contacts for practitioners

Statements

Focusing on anaemia. Towards an integrated approach for effective anaemia control (2004)

Iron supplementation of young children in regions where malaria transmission is intense and infectious diseases highly prevalent (2006)

Joint statements by WHO and UNICEF. Available from WHO.

Preventing and controlling micronutrient deficiencies in populations affected by an emergency (2006)

Joint statement by WHO, WFP and UNICEF. Available from WHO.

Technical reviews, books and guides

Iron deficiency anaemia: assessment, prevention and control. A guide for programme managers (2001)

Deals with indicators for monitoring interventions to combat iron deficiency. Approaches to designing national iron deficiency prevention programmes are discussed. Available from WHO.

Maternal anaemia: a preventable killer (2006)

Details the causes and consequences of iron deficiency, IDA and anaemia, and emphasizes the importance of implementing a package of interventions to address multiple causes of anaemia.

Available from A2Z Project FREE.

Learning about micronutrient nutrition

A series of three interactive computer-based learning modules on CD-ROM. Volume 1 – iodine deficiency, Volume 2 – vitamin A, Volume 3 – iron deficiencies. Available from the Micronutrient Initiative FREE.

Ending hidden hunger

A slide show which provides a detailed overview of micronutrient deficiencies including anaemia and their solutions.

Available from the Micronutrient Initiative FREE.

All we expect – nutrition: a basic human right

A video which highlights the significance of micronutrient malnutrition, especially as it affects women. It outlines the effects of iron, iodine, and vitamin A deficiencies. Some examples of how to overcome the deficiencies are given. Available from the Micronutrient Initiative FREE.

Conferences

Consequences and control of micronutrient deficiencies: science, policy, and programmes – defining the issues

16–18 April 2007. Istanbul, Turkey

This is the Micronutrient Forum's first international meeting.

Participants are expected from international agencies, national ministries, educational and research institutions, food and chemical industries, and NGOs. For information: www.a2zproject.org/forum.htm

SIGHT AND LIFE workshop on nutritional anaemia

27 September 2006, Barcelona, Spain

This workshop brought together leading nutrition scientists.

The presentations will be published in a manual addressing nutritional anaemia. For information: www.sightandlife.org

Useful contacts

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Some of our readers

Letters from around the world



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- distributed to readers in 102 countries
- read by over 1,000 people with numbers growing daily
- read in government ministries, UN agencies, Red Cross Societies, international and national NGOs, academic institutions and private organizations.

Bangladesh

Presently, I am working as a Project Manager of the Integrated Nutrition Project managed by Plan Bangladesh since 2003. I believe I will be able to learn, interact, and share views on nutrition activities and progress from an international perspective through this nutrition publication.

Dr Tofail Md Alamgir Azad, Project Manager, Dhaka

Ghana

I am a nutrition practitioner in one of the local clinics here. As we are not from the capital city, most of the women are farmers and have children and the cost of their living is very hard. Every five weeks, we beat our local gong and when they come we talk with them about how to take care of themselves and their children – to eat well especially green vegetables and how to use our local water here.

Andrew Nar Korli, Nutritionist, Koforidua ER

USA

First of all, I wanted to congratulate you and the rest of the nutrition team on the high quality of text and visuals! This is an excellent resource for anyone who is promoting, supporting and protecting breastfeeding – well, basically, for just about anyone.

Rebecca Magalhaes, Director, External Relations & Advocacy, La Leche League International, Illinois

Zambia

I am a community health worker in the marginalized community here in Mpika District, interested in receiving and learning more in human nutrition, as more people are dying of poor nutrition. Now, through reading nutrition, there will be change in the community and health will be improved.

Andrew Bwalya, Community Health Worker, Mpika District

Uganda

Katwe Youth Development Association is a charitable NGO dealing with street children, orphans and the needy youth. The organisation is located in Katwe II parish, Makindye Division Kampala city. As an organisation helping vulnerable children, feeding is one of the activities that we offer. We need more information on feeding and nutrition.

Josephine Akisa, Social Worker, Kampala

India

I am working as a health coordinator in the Kingsley Community Centre, a voluntary organisation working among poor village people. Last year's survey showed that 90 per cent of pregnant women, lactating mothers and young adolescent girls have nutrition deficiency problems. We have planned to organise an awareness program on nutrition and nutritious food preparation.

S Ananthan Ambrose, Health Coordinator, Tamil Nadu.

Tanzania

I am an employee at the district agriculture office. My activities are mainly with grassroots communities on food production, food storage and family food planning. I am sure nutrition can be of great help in my day-to-day activities.

Christopher Kiula, Agriculture Ext. Officer, Sengerema District

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nutrition has arisen from the growing acknowledgement that while technical nutrition problems have largely been solved, problems of implementation remain. The need to identify nutrition initiatives that work in practice continues, yet there is little documentation of nutrition initiatives at a grassroots level, let alone any detailed analysis of the ingredients that make them work or not work.

nutrition is a new **FREE** tri-annual publication specifically for nutrition practitioners. It aims to provide an opportunity for those working in development to share valuable practical experiences (both successful and less successful). Nutrition practitioners are encouraged to write up their experiences and can be given help by the editors to ensure that their contributions are clearly written.

nutrition is produced thematically, so that the magazine can be used as a resource for a particular subject area. We welcome ideas on future themes that you would like to see covered.

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