FEEDING THE EARTH

MICRONUTRIENTS FOR MACRO IMPACTS

Fighting Malnutrition through Micronutrient Fertilization

Billions of people, mostly in developing countries, suffer from micronutrient deficiencies, sometimes called "hidden hunger". The micronutrients most commonly associated with human health problems on a global scale include iron, zinc and iodine, but selenium and fluorine deficiencies are also widespread. In contrast to food security, nutrition security has traditionally been viewed as being within the realm of health professionals. Yet the entire agri-food chain has a vital role to play in addressing this problem. Producing more nutritious food and feed, or "farming for health", should therefore be a central objective. This means increasing micronutrient content through fertilization, which holds out the promise of fighting deficiencies in soils, plants, animals and people.

Micronutrient deficiencies are a major public health concern

The importance of micronutrients for the health of plants, animals and people has been recognized for many years. However, micronutrient deficiencies in humans became a priority issue rather recently. Despite the great nutritional importance of micronutrients, they are found in very low concentrations in most living tissues. According to a World Health Organization (WHO) report, zinc (Zn) and iron (Fe) deficiencies rank fifth and sixth, respectively, among the ten most important health risk factors in low income countries. As many as two billion people are thought to be affected by iron deficiency. An estimated 740 million people are at risk due to zinc deficiency, and nearly 50 million suffer from brain damage related to iodine deficiency.

Essential micronutrients for humans, livestock and crops
(Welsh, 2008; Alloway, 2008)

	Humans	Livestock	Crops
Boron	✓	✓	✓
Cobalt	✓	✓	✓
Copper	✓	✓	✓
Manganese	✓	✓	✓
Molybdenum	✓	✓	✓
Zinc	✓	✓	✓
Iron	✓	✓	✓
Iodine	✓	✓	–
Fluorine	✓	✓	–
Selenium	✓	✓	–
Chlorine	–	–	✓
Chromium	✓	–	–
Silicon	✓	–	–

Providing micronutrients fights hunger and malnutrition and promotes economic development

In the field of crop nutrient management, an emerging concern is how to ensure that micronutrient levels in harvested products are adequate for human nutrition. Much of the relevant research focuses on the bioavailability of zinc, selenium, and possibly boron and iodine in staple cereal grains, wheat and rice. The use of iron for agronomic biofortification is not viable since this essential nutrient is not mobile. Nevertheless, increasing micronutrient density and bioavailability warrant consideration in a greater number of crops. In human and animal diets the range of essential micronutrients is broader than in the case of plants, extending to a number of organic compounds including vitamin A. The importance of adequate micronutrient levels of chromium (Cr), cobalt (Co), iodine (I), selenium (Se), silicon (Si) and fluorine (F) should also be considered.

Three broad strategies can be pursued to boost micronutrient levels in foods commonly consumed by the general public:

- Agronomic biofortification: determine how to use agronomic means, particularly fertilization and crop management, to increase micronutrient levels in the edible parts of plants;
- Genetic biofortification: determine genotypic variations and micronutrient levels in crops in order to breed more nutritious varieties;
- Food supplementation: determine the prospects of increasing the bioavailability of micronutrients in food products.

Impacts of micronutrient deficiencies on food production and human health

Impacts on crop production

- reduced yields;
- poor quality produce, e.g. low oil content, poor fibre quality, deformed fruits;
- decreased N fixation by leguminous crops;
- reduced crop vigour ;
- low germination rates;
- shorter storage life;
- reduced efficiency of macronutrients.

Impacts on human health

- premature deaths;
- impairment of mental and cognitive development;
- reduced productivity, with higher rates of chronic disease and disabilities;
- increased sensitivity to disease.

Micronutrient fertilization or agronomic fortification is a proven strategy to fight deficiencies

Despite the small amounts of micronutrients that are needed by plants, deficiencies of one or more of them occur in many cropping systems. Soils poor in micronutrients may cause crop and food deficiencies, resulting in deficiencies in animals and people. Soils may be naturally low in certain nutrients, or they may become deficient through nutrient removal by crops over the years ("nutrient mining") without replenishment – or when farmers grow high-yielding varieties that have higher nutrient requirements. Generally, the micronutrient requirements of crops are met by adding micronutrient fertilizers either directly to soils or as foliar spray. Low concentrations of micronutrients (typically a few kilograms per hectare) are sufficient for optimum crop production. Increasing the micronutrient density of food crops for human health reasons could require higher application rates than those needed to achieve optimal crop yields.

Several application strategies exist for agronomic fortification:

- Blended fertilizers: Bulk blending of granular macronutrient and micronutrient fertilizers is widely practised. A large number of blends of different grades can be produced regionally to meet specifications for different soils, crops, or even particular fields;
- Fluid fertilizers: Micronutrient compounds can be added to fluid N, NP or NPK carrier fertilizers for soil or foliar application;

- Compound fertilizers: In compound fertilizers the micronutrients are incorporated during manufacture. They are either added during the production of fertilizer granules or sprayed onto the granule surface;
- Controlled-release fertilizers: These are polymer-coated granules or prills designed to allow a slow dispersal of the nutrient content in the soil. A wide range of such products contain micronutrients;
- Foliar spray: Foliar application of micronutrients is the method of choice for some field crops in Europe and North America, as well as for many fruit, vegetable and flower crops around the world. Its importance for field crops is increasing, especially in developing countries. Micronutrients can be applied to crops in liquid form or as a suspension;
- Fertigation: Micronutrients can be applied in water-soluble solutions through irrigation systems, particularly trickle or drip irrigation;
- Hydroponics: Micronutrients are applied in water-soluble solutions in systems that use inert material such as gravel, sand, perlite or rockwood instead of soil.

Finding ways for micronutrient products to reach small farmers

A wide range of micronutrient fertilizer products exist, but their distribution and affordability vary according to geographical regions. Greater emphasis needs to be placed on sharing existing knowledge and products with farmers. In many countries where there is clear evidence of micronutrient deficiencies and of the benefits of micronutrient fertilizer use, this has not been translated into widespread adoption. Since small farms require only limited amounts of micronutrient fertilizers, there is a need to market products that meet this requirement. New application, packaging and distribution strategies are also needed for the reliable supply of micronutrient fertilizers to markets where there have been failures, despite evidence of demand and of substantial benefits in terms of yield.

The fertilizer industry has an important role to play in finding solutions to "hidden hunger"

The fertilizer industry has a significant role to play in those parts of the world where large numbers of people suffer from deficiencies of micronutrients such as zinc, selenium, boron and iodine. These four micronutrients can be supplied through fertilization. Strong market development opportunities constitute a powerful business case for the fertilizer industry to contribute to human well-being by making micronutrient products available.

The International Fertilizer Industry Association (IFA) recently launched an initiative to assess **linkages between fertilizer applications and human health**, with the ultimate objective of developing practical fertilizer recommendations that combine crop productivity, environmental protection and human health considerations. In this context, IFA works in close partnership with the HarvestPlus Biofortification Challenge Program and the HarvestZinc project. The Association also manages a joint task force on zinc fertilization with the International Zinc Association (IZA).

Macronutrients and micronutrients

All essential nutrients (micro and macro) should be available, but in varying quantities.

Plants require macronutrients in large amounts. The "primary nutrients" are nitrogen (N), phosphorus (P) and potassium (K). Sulphur (S), calcium (Ca) and magnesium (Mg) are "secondary nutrients".

Micronutrients (or "essential trace elements") are required in very small amounts for proper plant growth. They need to be added when not provided by the soil. Some (e.g. zinc and iron) are essential to all plants, while others (e.g. chlorine and molybdenum) are essential to only some plant species. In all, eight micronutrients that are essential to crops have been identified:

- Boron (B);
- Chlorine (Cl);
- Cobalt (Co);
- Copper (Cu);
- Iron (Fe);
- Manganese (Mn);
- Molybdenum (Mo); and
- Zinc (Zn).

Micronutrients, like macronutrients, should be applied following the principles of fertilizer best management practices (FBMPs). Optimum benefits can be obtained by using the right product(s) at the right rate, right time and right place – the 4Rs. The fertilizer industry works with farming communities worldwide to teach farmers the best way to use their products. Best practices need to evolve constantly. Unless supply increases at the same rate as crop removal, deficiencies may emerge where they did not previously limit crop growth. However the continued use of micronutrients may lead, over time, to excessive levels that could threaten food safety or environmental quality, particularly in the case of micronutrients such as selenium where there is a narrow margin between deficiency and toxicity.

Stakeholders need to unite to carry out agronomic and public health projects

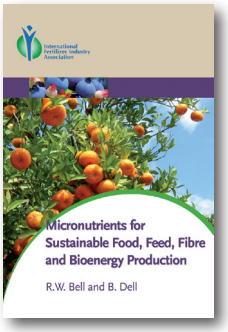
Fertilizer manufacturers, distributors and agronomists continuously need to find ways to keep information about locations and areas affected by micronutrient deficiencies up-to-date. It is important for the most appropriate and cost-effective technologies to be transmitted to farmers, with the support of good extension services.

Partnerships should be established among stakeholders, including:

- **The scientific community**, which develops and provides access to data on micronutrients in soils, crops, animals and humans;
- **Plant breeders**, who need to know a crop's requirements for higher and more efficient nutrient uptake or higher micronutrient bioavailability;
- **Extension services,** both private and public, which need to transfer appropriate technologies to farmers; and
- **Governments**, which need to design policies that address micronutrient deficiencies as part of their strategy to attain food and nutrition security.

A paradigm shift is needed with respect to agricultural reforms that **promote linkages with human health and development**. Policymakers should provide an enabling environment for the use of fertilizers that contain appropriate micronutrients.

In summary, the production of high-quality, nutritious food through increased agricultural productivity – focusing on more efficient, effective and sustainable use of all available nutrient resources – will help restore the food supply and demand balance, making food affordable, increasing farmers' incomes and reducing the number of those who are food-deprived, hungry, malnourished and undernourished. Fighting micronutrient deficiencies is crucial to the health and economic development of millions of people worldwide.



Reference:
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