Global impact of micronutrient deficiencies

Author: Argus media

E: info@argusmedia.com

In recent years significant awareness and acceptance have begun to emerge of the important role of micronutrients for the health and productivity of crops, humans and animals. It comes as no surprise that many of these studies were carried out in regions of the world where micronutrient deficiencies were found to have the earliest and largest impact.

In this paper a comprehensive study, created by the Argus Consulting Services team, provides extensive insight into the essential role of micronutrients and the enhanced profit opportunities they offer in agriculture. A technical reference and also a practical commercial resource, this study provides a clear view of the economics of micronutrient use, exploring the perspectives of all market participants – fertilizer producers, traders, retailers and farmers.

argusmedia.com

Argus White Paper: Global impact of micronutrient deficiencies

In recent years significant awareness and acceptance have begun to emerge of the important role of micronutrients for the health and productivity of crops, humans and animals. Since the 1990s there have been an increasing number of studies beginning the process of identifying and quantifying the extent of micronutrient deficiencies and their impact on soil and crop productivity and economics, as well as attempting to assess the cost of human and animal malnutrition. It comes as no surprise that many of these studies were carried out in regions of the world where micronutrient deficiencies were found to have the earliest and largest impact which, as a general rule comprise:

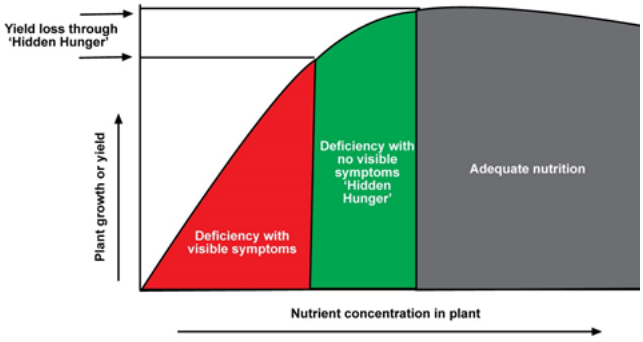
- Regions with less robust soils and inherently low fertility levels;
- Zones with continuous cropping without properly balanced fertilizer practices, and in many cases none at all;

Many of these impact studies were, and continue to be, focused on the developing countries of Asia. Although over the past decade, researchers in developed regions have started to pay more attention to the global impact of micronutrients on crop, human and animal health and productivity.

A higher incidence of micronutrient deficiency in crops in recent decades is the result of more intensive methods of agricultural production, particularly increasing amounts of applied NPK and new crop species and/or cultivars. Where clinical symptoms are present, such as blind grain sites in cereals or a reduction in marketable quality of a fruit crop, it is relatively straightforward to gauge the general impact of a micronutrient shortage; but where sub-clinical deficiency or hidden hunger occurs then the impact cannot be judged.

Hidden Hunger

The figure below illustrates the relationship between increasing the availability of a micronutrient, and crop response in terms of yield and quality characteristics.



At low levels (left curve) the impact is greatest, leading to the development of clinical symptoms, shown here as chlorosis (yellowing) in the leaves. However, in the absence of symptoms (middle curve), when the crop looks healthy, hidden hunger can still have a significant impact on crop yield and quality. In the case of crops sold based on their appearance, such as high-value fruits and vegetables, the occurrence of clinical symptoms of micronutrient deficiency would have a serious impact on marketability and hidden hunger can lead to symptoms of deficiency developing after harvest — during distribution and storage — with equally serious consequences for the producer and potentially the retailer as a result of reduced shelf-life.

In many parts of the world, the impact of hidden hunger may have a greater economic impact than more severe deficiencies because farmers, and their advisors, are not sure of the causes of disappointing yields and quality, even when they are applying sufficient amounts of the primary nutrients, N, P and K. This may lead to more primary nutrients being applied, which only exacerbates micronutrient shortages. This is both uneconomic and leads to the undesirable loss of particularly N and P into the environment. Enthusiastic over-application of primary nutrients, seen by farmers in developing countries as the only route to increase yields, has had similar consequences and environmental impact.

Human Impact

Over 3 billion people are believed to suffer from the impact of micronutrient deficiencies, particularly in developing countries. Even mild levels of micronutrient malnutrition (hidden hunger) may damage mental and physical development, lower disease resistance and cause blindness and other ailments in children; and the costs of these deficiencies in terms of lives lost and poor welfare are very significant. For example, The Lancet medical journal in 2008 published a landmark series of articles highlighting the impact and human costs of micronutrient deficiencies, including a study showing that over 450,000 deaths annually in children under the age of 5 in the developing world are due to a deficiency of zinc alone. Another study found that hidden hunger reduces the economic productivity of adult men and women due to increased risk of illness and reduced work capacity. In the same year, a panel of eight Nobel Laureates attending the Copenhagen Consensus meeting were asked to imagine they had $75 billion to spend on causes that would be the most cost effective solutions to global challenges (The Economist, March 24 2011). Two of the top-five ranked solutions were related to micronutrients.

The underlying reasons for the increasing emergence of micronutrient deficiencies can be traced back to the population explosion following World War II, which resulted in what we now know as the Green Revolution. New high-yielding varieties of maize (corn), wheat and rice combined with increasing ap-

plications of fertilizers, mainly N, and improved management of pests and diseases, dramatically increased food production, and by the 1990s the world was in surplus at least for basic (calorific) staple crops. In the decades following the Green Revolution, the World Health Organization (WHO) began to recognize a widespread increase in iron deficiency in humans, followed by a similar upswing in zinc deficiency (WHO, 2002). Concurrently, deficiency of selenium in large areas of China and Africa became of concern, while iodine deficiency has been increasing globally since the 1970s. In effect, the extent and impact of micronutrient deficiencies increased at a time when the threat of energy (calories) and protein shortages declined.

Micronutrient deficiencies reduce crop health and productivity, and consequently levels in food crops, resulting in malnutrition in humans and animals. During the decades of the Green Revolution soils globally suffered from the impact of progressive micronutrient depletion, also called 'mining', which directly and indirectly resulted in generally lower micronutrient levels in food crops and consequently in the diets of humans and animals. Together with the changes in crop types, the problem of micronutrient mining of soils has exacerbated the impact of micronutrient malnutrition globally. As a general rule, when soils are low in specific micronutrients then the extent of deficiency in crops and human malnutrition will usually reflect this.

Livestock Impact

The impact of micronutrient deficiencies on animal health has not received the level of attention seen in human nutrition, but there are still many valuable studies that have identified the effect on livestock health and productivity worldwide. Increases in meat and dairy product consumption particularly in the developing countries of Asia and Africa will mean that there will be benefits from more detailed studies on the impact of deficiencies upon livestock health and productivity.

The following tables show the increase in meat and milk consumption from 1983-97, and the forecast trend from 1997 to 2020. These demonstrate the economic impact that micronutrient deficiencies could have on animal health and productivity, if not corrected. As with crops and humans, hidden hunger in animals is more extensive than severe micronutrient deficiencies. Micronutrient hidden hunger can influence the survival, vigour and immunity to disease of lambs, as well as on the fertility and milk production of dairy cattle, demonstrating the economic benefits of application of micronutrient fertilizers to pastures to prevent their occurrence.

Per capita meat and milk consumption by region

	Meat		Milk	
Region	**1983**	**1997**	**1983**	**1997**
China	16	43	3	8
Other East Asia	22	31	15	19
India	4	4	46	62
Other South Asia	6	9	47	63
South East Asia	11	18	10	12
Latin America	40	54	93	112
West Asia & North Africa	20	21	86	73
Sub-Saharan Africa	10	10	32	30
Developing World	14	25	35	43
Developed World	74	75	195	194
United States	107	120	237	257
World	**30**	**36**	**76**	**77**

WANA = West Asia & North Africa

Per capita meat and milk consumption by region

	Projected growth	Total 1997	Total 2020	% of world total	Per capita 1997	Per capita 2020
Developed world:						
Beef	0.5	30	34	40	23	25
Pork	0.4	36	39	33	28	29
Poultry	1.5	28	39	36	22	29
Meat	0.8	98	117	35	75	87
Milk	0.6	251	286	43	194	210
Developing world:						
Beef	2.9	27	52	61	6	9
Pork	2.4	47	81	67	10	13
Poultry	3.9	29	70	64	7	11
Meat	3	111	217	65	25	36
Milk	2.9	194	375	57	43	62

There is a fundamental causal link between micronutrient deficiencies in crops, humans and animals, and it is ultimately defined by the low levels and/or availability of micronutrients in the 'parent' soils. We can therefore state with confidence that micronutrient deficiencies have an impact on every step from plough to fork in the food chain.