13TH INT'L ANNUAL FERTILIZERS FORUM

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13th AFA Int'l Annual Fertilizers Forum &Exhibition

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Intercontinental Hotel- Sharm El-Sheikh

Balanced Fertilization for Optimizing Plant Nutrition

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SESSION I

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The Changing Role of Agriculture in Economic Development

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Jordan

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Balanced Plant Nutrition: A Basis for Plant, Animal and Human Health

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1. Introduction

The Arab World is faced with many constraints, including: limited arable lands per capita (about 0.22 ha); severe water shortages (16 countries below the deficiency level of 500 M^3/capita of annual renewable water resources); poor soil fertility; low investments in irrigation schemes; non-adequate prices for agricultural commodities and poor or failing marketing systems. The marked role of chemical fertilizers was recognized by several FAO publications and was reported that over 55% of the increase in agricultural production was mainly ascribed to the fertilizers use (FAO, 1998). The existing food gap in all Arab countries (perhaps except Syria) would necessitate a vertical expansion in agricultural production to meet the increased demand for food. The Arab countries are currently using around 3.5 million tons of NPK fertilizers (FAO ATAT, 2002), with the big share goes to Nitrogen. The phosphatic fertilizers are used at a smaller rate and then the potassium, if remembered. The minor elements (micro-nutrients) are used at even smaller quantities, in a random manner and hardly well-considered in the fertilization programme. Perhaps, in green house production and in some modern farms such consideration is given to all essential elements, including minor elements. Since plants constitute the basic feed item for animals; then it follows that a healthy and balanced plant produce, in terms of its nutrients content and quality, would make it an appropriate healthy item to meet the animal nutrient requirements.
In addition to a generally low fertilizer rates applied in the Region (overall average70.5 kg/ha); the balance between these elements is in appropriate. The NPK elements added, in general, run around the ratio of 7:2:0.6; while a more appropriate ratios ought to be close to 5:2:1 (Hamdallah, 2000).

Some dramatic cases of deficient animal feed were responsible for some ailing animals which were difficult to relate to any known animal disease. The Region witnessed three Meetings (held in Egypt, Jordan and Syria) during the last few years that were dedicated for discussing the current concerns of food quality and its content vis-a-vis its impact on human nutrition and health, particularly in children. The saying *"Agriculture is the Guardian of Health"* is a correct one, to the extent that food quality –being the basis of human and animal health-depends on the correct use of means of crop production, specially fertilizers.
Several approaches were put forth for balancing animal feed and human food, including fortification programmes for children food and adding all kinds of supplements to their milk and other food formulations. This paper would try to focus on the intricate relationships between plant nutrition, animal nutrition and the impact on food chain for humans. Such approach is believed to provide a better tool for enriching food and feed items and make them more balanced and healthier than any artificial additives.

2. Essentiality of Plant Nutrients

Soil is the cradle for growing plants and raising animals. Plants require some *17 essential elements* in order to grow healthy and produce economic crops. Some of these elements are needed in relatively large amounts, and thus called *"Macro-nutrients"*, can be absorbed from soil solids (N, P, K, Ca, Mg, S). The rest, which are also essential for plants but at lower rates and thus called *"Micro- Nutrients"*, exist in the soil solids (Fe, Cu, Mn, Zn, B, Cl, Mo, and Co). From the 17 elements listed above, it's clear that the majority of them are essential nutrients for both plants, animal and humans, though at various forms and with different doses and growth stages of each living organism. Selenium, for example is not essential for plant but it is *essential for animals and human* health.

Not only the total content of a specific element is important, but also its chemical form and its relative concentration with other certain related elements in the soil solution. Therefore, it is significant in studying the soil and plant fertilizer programmes to identify the availability of plant nutrients by characterizing the various occurring chemical forms of the element: *soluble, exchangeable; fixed and total,* in addition to the element concentration or content.

3. Balanced Fertilization

In addition to the nutrients in the right amounts and ratios, some favourable soil conditions should prevail like: soil aeration, suitable pH, well-developed rooting system adequate water supply, etc.). The three basic *"fertilizer elements"* (NPK) constitute the bulk of chemical fertilizers produced and utilized, since they are required by all plants. There is ample evidence from literature that describes the importance of having favourable ratios of concentration such as N/P; N/K; Ca/P; P/Zn; Fe/Mn; Fe/Zn; and so on. However, several studies in the Region concluded that to maintain successful crop production, the 3 main fertilizer elements (NPK) need to be applied at this ratio: 5:2:1. The statistical data from the Region indicate that the current use of (NPK) is around 7:2:0.6. The dominance of Nitrogen used is due to its relatively lower prices and to its quick observable results on the plant vegetative growth. The existence of several N-producing Chemical Fertilizer Factories throughout the Near East (both for urea and other ammonium compounds) perhaps contribute to the favourable use of N. On the other hand, the bias against the use of Potassium is clear. It is quite indicative to point out that in the whole Region; only *one factory* for producing Potassium Chloride (Muriate of Potash) exists in Jordan, with a capacity of about 1.5 million tons/year. Although the general impression that soils of the Region are rich in K; however, the intensive cropping of lands would deplete those original soil reserves. It is worth noting that Nitrogen Manufacturing Complexes exist in almost all Gulf Countries (basically due to the abundant supply of natural gas); in addition to Egypt, Iraq, Syria and others. Phosphorus producing factories exist evidently in those countries where the P deposits and rock phosphates occur, such as Morocco, Tunisia and Jordan.

However, a balanced fertilization programme should also include the micro-nutrients and not only the above-mentioned macro-ones. It is clear from the Fertilizer Consumption statistics of the Region countries that these minor elements are not given the due

consideration and attention they deserve. Therefore, hunger signs and deficiency symptoms (leading to yield losses due to insufficient application of these micro-elements), are wide spread in the Region (El-Fouly, 2005).

4. The Human Food Chain

4.1 A Global Concern on Food Safety

The last few decades witnessed a growing public awareness on food quality and health, reflected by recognizing the need for standards for agronomic and animal products that constitute the human food chain. Similar concerns include worries about the use of irradiation in food preservation and biotechnology in food production (GMO's); as well as diseases linked to intensive animal farming and increased international trade. A good deal of these global efforts are directed to regulate, control and ensure the safety of human food items through legislation and introducing standards and codes of practice, for which the famous *Codex Alimentaris* is a vivid example of these endeavours. This FAO and WHO joint Commission is charged with setting of food and agricultural safety and trade standards. As concerns rise about the safety of the food chain; the 26th. Session of the Commission convened at FAO, Rome in July 2003, bringing together some 600 worldwide experts in food safety and agricultural trade. The Commission adopted more than 50 new safety and quality standards, some new guidelines and others that are revisions of old standards. The guidelines cover food safety, not environmental risks and include pre-market safety evaluations, product tracing for recall purposes, and post-market monitoring. They cover the scientific assessment of genetically-modified plants (GMO's); as well as establishing broad general principles to make analysis and management of risks related to biotech foods uniform across Codex's 169 member countries. The recent years witnessed the use of few trade terms that signify abiding by the new international marketing requirements like: Organic (no mineral fertilizers and no pesticides were used); GAP (Good Agricultural Practices); IPM (Integrated Pest Management); and HACCP (Hazard Assessment and Critical Control Points) to ensure the Food Safety Enhancement Programmes.

4.2 Land is the Starting Point

Because soils are the natural base for growing crops and raising animals; then it is imperative that its fertility will impose the quality and mineral content of such agricultural products. Therefore, nutrient deficiencies in soils are reflected not only on crop yields, but also on their contents of mineral nutrients. Food stuffs and animal feeds, containing low amounts of nutrients, would lead to mineral deficiencies in animals and humans. On the other hand, some serious animal diseases of real concern to humans, like the Mad Cow Disease (BSE), are basically *animal nutrition–based problems*.

There were rare occasions in the Region when scientists working on various disciplines like (soil science/plant nutrition, human nutrition, veterinary/animal nutrition, as well as, medical sciences), would convene to study the inter-related problems and concerns of these domains. Only a multi-disciplinary approach to study those areas would produce plausible remedies to the nutrients imbalance and deficiencies in the human diet, that can be best offset by treating those deficiencies in plants and consequently in animals. To deal with the potential problem at the *point source* would be more effective and feasible than addressing the risk later through some *artificial additives.*

4.3. Fortification Programmes

Agriculturists and Plant Nutritionists believe strongly that a balanced fertilizer programme for each crop variety, accommodating all required essential elements, would be the most feasible and natural solution to achieving *a healthy complete diet*. Other professionals like Dietitians and Medical Doctors would defend having some *food fortification programmes,* through adding s*upplements* like micro-nutrients, vitamins, etc. to food and feed items. The well-known GAIN (Global Alliance for Improved Nutrition) programme received its initial funding of US$50 million grant in 2002 from Mr. Bill Gates. Another US$20 million were also received in 2006 from Bill and Melinda Gates Foundation grant. The announced aim was to strengthen efforts to address poor nutrition, which has been linked to almost half of all child deaths worldwide. The Executive Director of GAIN defended his programme by saying "Food fortification, adding vitamins and minerals to the foods that people eat every day, is a proven solution to a genuine health and development problem and it only costs around 25 cents per person per year." (GAIN, 2006).

4.4 Genetic Manipulation

It should be noted that some studies related to *genetic manipulation* are targeting the production of major crop plants for both human and animal consumption with nutritional properties such as: enhanced macronutrients, improved fatty acid and essential amino acid composition; as well as improved micronutrients, vitamins or enhancing the plant *uptake efficiency for* NO_3 to address nutrient deficiencies. A good deal of research work has been going on in several countries, particularly the US, Australia and others in Europe to produce the so-called *"Super or Giant Crops"*. The term *Bio-fortification* becomes also popular in the media. This entails producing some crops with extra nutrients or vitamins built-in. One of the basic criticism to these crops that they are Genetically Modified (GMO's) which are still baneed from use in many European and other countries. Some believe that Super Crops might also yield *Super Weeds*, or even have the extreme of a "*Grain Problem*" scenario.

The area planted with GMO crops reached about 78 million ha in North and South America, which counts for 94 % of the world area. This also includes the top four countries: (US, Argentina, Canada and Brazil). Main crops grown are: maize, soybean, canola and cotton (Traxler, 2004).

However, in Adelaide University, Australia researchers are working on "*Selective Breeding" and not GMO's.* Such crops are already around like: Rice with extra Iron (Fe) been used in the Philippine, sweet potato boosted with Vitamin-A in South Africa, as well as enriched wheat in India and fortified potato in Peru (Teenhugger, 2005).

It should be stressed in this regard that such efforts are geared towards more agriculture production for more food for hungry people (estimated at more than 800 million, world-wide). There is an estimated annual loss of lives close to about 24 million deaths from mal-nutrition related to micronutrients deficiency. However, the zeal towards having more food for more people should not obscure the other important attention that needs to be given to the *people's food and nutrition.*

4.5. Pant Nutrients Impact on Product Quality

Links between plant nutrition and the quality of vegetal foodstuffs is well established. Almost one half of all human diseases are caused directly or indirectly by in correct or in adequate nutrition. Both in regions of short food supply and abundant food production; producing foodstuffs of desirable quality is required to ensure healthy food for consumers and good return for producers

Since the use of fertilizers becomes a reality and necessity in crop production; the challenge becomes then to prove that the *increased in yield is not on the expense of produce quality*. This concept also stems from the "*Value of Naturalism*; *what is natural is good; and what is un-natural and artificial is not good"* (Finck, 1983*)*. This argument was behind the bias against the use of synthetic chemical fertilizers, and even to group fertilizers with other agricultural chemicals (pesticides which are basically poisons to animals and humans). This led to some public confusion and even certain governmental legislation to discourage or limit the use of commercial mineral fertilizers. This argument could be faced with the fact that *both phosphate and potassic fertilizers come from "natural deposits"*, which are only slightly processed to produce them in a more available chemical form to plants. It should be noted here that plants don't *prefer* any specific nutrient formula. For example, nitrate whether it comes from an organic source or a chemical one, it is the same since all forms of N are converted to NO_3 when absorbed by plants.

The new trend of promoting *"Organic Agriculture"* is claiming a considerable deal of acceptance and recognition, with a good deal of interest world-wide. Of course, organic food products are marketed easily and at higher prices and many countries in the Region started developing plans for expanding this approach, with real big and sometimes exaggerated hopes and expectations. No doubt that *Organic Products* attract customers and bring higher return to growers; yet this mode of agricultural production can't possibly be a corner-stone for crop production. Because it hardly represent 2% out of the overall production in American agriculture; then it can't be a strategy for agriculture production, in the general sense. Its great potential can be attached to some *selected high-value cash fruits and vegetables* and perhaps *medicinal plant* products. For marketing these products, some requirements should be secured like: accreditation, regulations and standards that regulate this type of farming practices.

4.6 Plant and Animal Nutrition

Sufficient supply of N and P is essential for protein synthesis in plants. Potassium is needed for carbohydrate formation, and other minor elements, such as Fe, Mn, Cu and Zn, play key role in all biological processes of organisms.

Almost in all Near East countries, soils are generally characterized by their calcareous nature, alkaline pH, low organic matter, and inherent low levels of N and P, as well as the minor elements (Fe, Mn, Cu, and Zn). Below are some specific relevant observations:

(a) Lime-induced chlorosis, mainly due to Fe and Zn deficiency is common and can be easily observed in fruit tree-orchards in the Region (El-Fouly; 1998). Therefore, the

supplementation of such soils with the deficient elements is a necessity to grow healthy plants.

(b) It became a practice in Europe to spray Selenium (Se) compounds on rangelands for the benefit of grazing animals. Bashour (2002) conducted some pioneering studies in the Region by assessing the Se level in soil samples collected from various countries in the Near East, and found those levels are marginal. Luckily, soils of the Region are inherently low in phosphorus (P) which would obligate farmers to add P fertilizers that contain some impurities of Se and thus compensate for the soil Se deficiency.

(c) Several studies pointed out that Zn deficiency could have its serious negative impact on the human body (Malakouti, 2004).

(d) The Selenium (Se) deficiency in the forage crops raised on pure sandy soils in the Kufra Project in Libya desert during the late 1970's was a puzzle to solve until it was investigated. It was found that the problem occurred due to the low Se content in the forage fed to animals, which was a result of the element's low content in those desert sandy soils. Although Se is not an essential plant nutrient; it is so for animal nutrition.

(e) As it does in animals, Se functions in human body as an anti-oxidant and a component of another antioxidant (glutathione peroxidase). Deficiency of either substance impairs the human body's immune system and its ability to fight infections (NAS, 1983). Selenium was also reported to have a protective effect against certain chemically-induced diseases; while its deficiency could cause some cardiac problems and prostate cancer in humans (Challem, 1995).

(f) A good example showing the *Influence of the Chain (soil-plant-man)* came from New Zealand; when certain soils were poor in available Mo (molybdenum), so naturally the vegetables grown on those soils contained too little Mo. Persons mainly subsisting on such vegetables had in-adequate Mo intake. As this micro-element (in addition to Fluorine) is essential for strong teeth; the tested school children teeth were less healthy and more susceptible to the incidence of caries (quoted by Finck, 1982).

5. Concluding Remarks

Below are some recommended actions on the above subject:

(i) Call upon Member Countries of the Region to conduct more research on role of micro-nutrients in plant, animal and human nutrition, especially elements such as Fe, Zn and Se that worth further studies.

(ii) Call on Fertilizer Producers to give due attention for making minor element fertilizers or compound fertilizers with the right doses of essential minor elements.

(iii) Call upon regional and international organizations to collaborate in promoting research and experience sharing, including supporting the information networking, related to minor element role in agriculture, aiming at achieving healthy and safe foods.

(iv) Call upon private sector in the Region (mainly food and fertilizer industries) to

allocate adequate funds for studying micro-nutrient role in producing healthy food , through their Research and Development association with relevant national research centers.

(v) Urge ministries and relevant research institutions to adopt the *Balanced Fertilization Programmes* in drafting the nutrients recommendations to include both plants and animals, as a means for producing balanced healthy plant and animal food items.

(vi) The need is there for adopting *Balanced Fertilization Programmes* that includes both plants and animals requirements, as a means for producing balanced healthy plant and animal food items.

(vii) Encourage dialogue and joint research programmes among scientists and researchers in plant, animal and human nutrition for identifying those intricate relationships that would lead to having a safe human food chain.

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