Plenary Lectures

Global Potassium Fertilizer Situation: Current Use and Perspectives

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> « *Agri cultura… est scientia, quae sint in quoque agro serenda ac facienda, quo terra maximos perpetuo reddat fructus* »
>
> Marcus Terentius Varro (First Century B.C.)

> "Agriculture is a science, which teaches us what crops are to be planted in each kind of soil, and what operations are to be carried out, in order that the land may produce the highest yields in perpetuity".

How appropriately this line was quoted in a recent article on crop protection management (Kern and Germandi, 2001). This quotation emphasizes the importance that the farm inputs industry places on sustainability and it reinforces the need to emphasize its message on the benefits of integrated crop management and integrated plant nutrient management.

Responsible Fertilization: Fertilizers are essential

Nearly 25% of the earth's terrestrial surface is devoted to agriculture. Food from agriculture, supplemented by fisheries, supports the world population of 6 billion people. Still, the FAO reports that more than 800 million people are chronically malnourished. While the global population is expected to reach 7.5 billion by 2020, the need for better and more food arises from the necessity to alleviate poverty and correct malnutrition and from the emerging requirements in developing countries associated with improved diets and better economic conditions. Agriculture will only be able to feed the increasing world population by promoting sustainable food production. In this context, R.B. Singh of the FAO stressed in his presentation at the 69th IFA Annual Conference in May 2001 that "sustained soil fertility and overall soil health are prerequisites to a sustained agricultural production. All out effort is thus needed to maintain and restore soil fertility and health".

The concept of integrated plant nutrient management offers a comprehensive system that integrates other production factors. The message is clear: mineral fertilizers provide plants with the nutrients required for their growth and development. In order to maintain soil fertility and productivity, to prevent land degradation and desertification, to alleviate soil nutrient mining and prevent erosion, nutrients removed by crops must be replenished through the application of plant nutrients, *including mineral fertilizers*.

More than 40% of the world dietary protein is derived from nitrogen fertilizers (Smil, 2000). Fertilizers account for close to 30% of the total increase in crop production during the 1960-2000 period, during which cereal production has doubled (Roy A.H., 2001; Pinstrup-Andersen, 1976). For the next 20 years, the world's farmers will have to produce 40% more grain, with the developing world doubling its meat production. The main driving forces for raising yields in most of the 20th century were population growth and technological changes (Poulisse, 2000). In the future, the driving forces will be income growth, shift in consumption patterns, and attentive consideration of environmental and social factors.

According to the FAO, 80% of the increase in crop production will be derived from higher yields and cropping intensity. The slow down in the expansion of arable land will stimulate further cropping intensity (multiple cropping and reduced fallow periods). The efficient and responsible use of mineral fertilizers will play a vital role in meeting future world demand for safe and nutritious food (FAO, 2000)

While the recycling and transfer of nutrients from non-crop areas, crop residues and animal manure can partially make up for the uptake of nutrients by harvested products, the use of external sources such as mineral fertilizers remains essential in meeting crop requirements and increasing crop production in many farming systems. Considering the importance of plant nutrients in agricultural production, it is imperative to establish the relationship between yield, use of plant nutrients, economic feasibility and environmental quality (Roy R.N., 1999).

Efficient Plant Nutrition: Balanced fertilization

The mineral fertilization of crops has proved to be a powerful tool for yield increase (Finck, 1998). However, there may be some misuse of fertilizers when trying to compensate poor growth caused by excessive losses on unsuitable soils or by the lack of certain nutrients. Farmers have tended to develop a very strong reliance on nitrogen fertilizers for maximizing crop yields, rather than targeting optimal realistic yields. Unbalanced fertilization has negative effects on the quality of food, fodder and on crop resistance to pests and diseases. Risk aversion is another hidden factor. In an assessment of economic risks in agriculture (Bosch and Pease, 2000), farmers viewed nitrogen input as a risk-reducing factor on yield expectations. The perception of yield risks led farmers to increase N application by 33% (Babcock, 1992) or applying 9% to 25% more nitrogen during spring split application on corn (Feinerman *et al.*, 1990). Economic risk perception is a driving factor for increasing nitrogen application to the detriment of other nutrients.

Effective plant nutrition involves both efficient and balanced fertilization. Efficient fertilization means the optimization of a soil's nutrient replenishment with the minimization of nutrient losses to the environment. Uneven fertilization results in over-fertilization of some areas, or under-fertilization of others. Moreover, if fertilization is to be efficient it must be balanced. The application of fertilizers in accordance with scientific recommendations is the best way of achieving efficient nutrient use with minimum losses. IFA has been promoting the efficient and responsible use of fertilizers through the distribution of its World Fertilizer Use Manual, one of the most requested publications at IFA. In addition, IFA has prepared "Guidelines on best agricultural practices" for a number of regions in different languages.

Potash Fertilization

Potash fertilization started in the 19th century when Justus v. Liebig discovered that plants need, in different proportions and quantities, nutrients such as nitrogen, phosphorus and potassium, in order to build up biomass. Today, potassium deficiency is recognized as an important limiting factor in crop production.

Potassium is an essential element for plants. The quantity of potassium absorbed by roots is second only to that of nitrogen for most cultivated plants, while the demand for potassium is higher for certain crops such as banana, soybean and fruits (SOPIB, 2001). Potassium promotes root water absorption and prevents unnecessary water loss by transpiration. At its early stages, potassium deficiency is reflected mostly in yield decreases. This early stage is called "hidden hunger" since no specific symptoms appear in the plant. As the intensity of the deficiency increases, significant symptoms appear: less strength of plant structures, less resistance to low water availability and less resistance to fungus diseases.

Potassium is indeed essential in agriculture and horticulture as it makes plant resistance to drought, frost and to a number of diseases and pests. It is essential for the development of the root system and fosters nitrogen fixation of leguminous crops. It improves the size and colour of crops such as fruits and enhances their quality through an increase in sugar content of crops such as fruits, carrots, onions, and sweet potatoes.

Lower potash application in the context of unbalanced fertilization results in a significant depletion of soil potash reserves, yield loss and higher economic risk for farmers. An analysis of the nutrient balances (Syers *et al.*, 2001) for the period 1961 to 1998 for six Asian countries (China, Indonesia, Malaysia, the Philippines, Thailand and Vietnam) indicated an overall annual potassium deficit of about 11 Mt K, which is 250% more than the current potassium fertilizer use. For China, the annual potassium deficit in 1998 was estimated at 8 Mt K (62 kg/ha); for Indonesia, 1.2 Mt K (41 kg/ha). Such deficit in China is creating a serious nutrient imbalance with major implications for food production.

Nutrient Imbalance: Regional and worldwide ratios

Worldwide, the imbalance between nutrients in favour of nitrogen has been growing. The ratio between nitrogen and potash is of special interest. Since 1960, the nitrogen-to-potash ratio has been decreasing, especially in developed countries. In developing countries, the nitrogen-to-potash ratio (N : K_2O) was quite low in the 1960s at 100 : 17, while the world average was 100 : 63 due to higher potash consumption levels in developed countries (100 : 77). During the 1980s, the world average was about 100 : 37 as the demand for nitrogen grew at a faster rate (7.7%/a) than that for potash (1.5%/a).

Political and economic changes in the USSR and Central Europe affected fertilizer consumption. Potash consumption in those regions dropped from a high level of 7.5 Mt in the late 1980s to less than 1.5 Mt in the 1992-94 period. This decline impacted on the world N : K_2O ratio, which dropped to a low of 100 : 26 in 1993. As world fertilizer demand picked up in the mid-1990s, the ratio has gradually recovered to reach 100 : 27 in 2000 (**Table 1**).

Table 1 : Nitrogen-to-Potash Ratio (N : K_2O), 1961-2000

Region	*1960s*	*1970s*	*1980s*	*1990s*	*2000*
World	100:63	100:49	100:37	100:28	100:27
Developing Countries	100:17	100:17	100:15	100:17	100:21
Developed Countries	100:77	100:63	100:55	100:43	100:37

From 1961 to 1980, the nitrogen-to-potash ratio in developing countries remained relatively steady, varying around 100 : 17. During the past two decades, the ratio slowly improved to 100 : 21 after dropping to 100 : 14 in the mid-1980s.

The ratios in large consuming countries in Asia demonstrate the important variation between countries in the same region. The small group of eight countries in **Table 2** represents close to 50% of world nitrogen use and only 30% of world potash use. This disproportion demonstrates the important market potential for potash in view of the lack of balanced fertilization.

Table 2 : Nitrogen-Potash Consumption and Ratio in Asia, 2000

Countries	*Nitrogen Mt N*	*Potash Mt K_2O*	*Ratio N : K_2O*
India	10.85	1.55	100:14
Pakistan	2.20	0.02	100:01
Indonesia	2.00	0.27	100:14
Malaysia	0.33	0.65	100:197
Philippines	0.48	0.12	100:25
Thailand	0.97	0.26	100:27
China	22.60	3.35	100:15
Vietnam	1.25	0.39	100:31
Subtotal	*40.68*	*6.61*	*100:16*
World	**81.73**	**21.90**	**100:27**
Share of world use	*50%*	*30%*	

Global Potassium Demand

During the past 40 years, world potassium consumption has increased 2.5 fold. Between 1960 and 2000, the world use of potassium fertilizers rose from

9 Mt to 22 Mt K_2O, despite a substantial fall in the countries of Central Europe and the Former Soviet Union since 1990 (**Table 3**). Potassium fertilizer use accounts for 16% of total fertilizer usage, compared with 28% in 1960. World potash consumption has been increasing since 1993, but is still far below the 28 Mt, which were consumed in the record year 1988.

Table 3 : World Fertilizer Potash Consumption (1961-2000)

Mt K_2O	***1961***	***1970***	***1980***	***1990***	***2000***	***1961-2000***
World	9.1	16.3	24.4	24.6	21.9	+2.3% / a
Developed Countries	8.6	14.9	20.2	17.5	10.6	+0.6% / a
Developing Countries	0.5	1.4	4.2	7.1	11.3	+8.3% / a
Share of developed countries	94%	91%	83%	71%	48%	

Potash consumption in the developed countries has increased 1.25 fold in the past 40 years, while the demand in developing countries expanded 22 fold from 0.5 Mt in 1960 to 11.3 Mt in 2000. In 2000, it was the first time that potash consumption in developing countries (52% of global demand) surpassed that in developed countries (48% of global demand, compared to 94% in 1960).

The annual growth rate of potash consumption averaged 8.3% in developing countries between 1961 and 2000, compared to 0.6% in developed countries. For the past two decades, annual growth rates in the developed countries have been negative: –1.5% in the 1980s, and about –5% in the 1990s, compared to sustained annual growth rates in the developing countries: +5.4% in the 1980s and +4.7% in the 1990s. At present, South, East and Socialist Asia account for 33% of the world's potassium fertilizer consumption, North and Latin America together for 37%, Europe and the CIS for 25%, the Near East for 1% and Africa and Oceania for about 4%.

In 2000, ten countries accounted for 72% of the world potash consumption (**Table 4**). The largest potassium consuming country in the world was the USA with 20% of the world consumption, followed by China with 15%, Brazil with 12%, India with 7%, and France with 5%. These five countries accounted for 60% of the world potash consumption.

As regards potassium products, since 1978/79 most of the increase in world potassium consumption has been in the form of potassium chloride or muriate of potash (MOP). Other products include potassium sulphate (SOP), potassium nitrate (NOP), and complex fertilizers that contain potassium. Potassium chloride dominates global sales with a contribution of 90%, followed by potassium sulphate (7%) and potassium nitrate (2%). Of importance, 95% of all MOP is directed to fertilizer use in agriculture. Almost all SOP is used in agriculture, and about 80 to 85% of NOP; the remainder 15 to 20% is for industrial applications (Horn, 2000).

Table 4 : Potash Consumption in 2000

Countries	*Mt K_2O*	*World share*
USA	4.30	20%
China	3.35	15%
Brazil	2.56	12%
India	1.55	7%
France	1.20	5%
Malaysia	0.65	3%
Germany	0.62	3%
Belarus	0.55	3%
Spain	0.49	2%
United Kingdom	0.42	2%
World	21.90	

According to the Sulphate of Potash Information Board (SOPIB), the world SOP consumption is characterized by a high use level in China, North Africa and the Near East. In China, the use of SOP is driven by a significant tobacco production, China being the largest tobacco producer in the world. The use of SOP in North Africa and the Near East is driven by the need to address salinization risks under a Mediterranean climate.

The share of straight potassium fertilizers in total potash use has remained fairly constant between 1961 and 1998, accounting for 65% (**Table 5**).

From 1960 to 1973, 52% of the increase in K_2O consumption was in the form of NPK and PK fertilizers. Between 1974 and 1998, all of the increase in the consumption of potassium fertilizers has been in the form of MOP. This increase was driven by both the growing appreciation of balanced fertilization using high-analysis potassium fertilizers, including SOP and NOP, and the introduction of blended fertilizers in major consuming regions.

Table 5 : World Consumption of Straight / Compound Potassium Fertilizers (1961-1998)

Mt K_2O	*1961*	*1975*	*1980*	*1985*	*1990*	*1995*	*1998*
Straight Potassium Fertilizers	5.8	13.1	14.6	15.9	16.4	13.3	14.4
Compound Potassium Fertilizers	3.2	8.3	9.8	9.7	8.3	7.4	7.7
Share of straight fertilizers	64%	61%	60%	62%	66%	66%	65%

Potash Consumption: Medium-term forecast

Potassium fertilizers are produced in few countries but are consumed in more than 80 countries. In 2000, close to 21.9 Mt K_2O were consumed and about 20.4 Mt were exported. The demand for potash is now again showing a relatively firm upward trend. During the past ten years, potash demand dropped significantly after the collapse of the CIS. This radical reduction in potash use could be singularized as the most important factor affecting demand since potash was first used as a fertilizer. Between 1989 and 1995, one-third of the world potash consumption was lost. Since 1995, potash consumption has increased at an annual rate of 1.3%. During the same time, nitrogen consumption rose at an annual rate of 0.82% and phosphate use by 0.86%. During the 1995-2000 period, most of this growth has occurred in developing countries with a 6.5% annual growth rate, compared to a negative rate of –2.4% per annum in developed countries.

In the medium term, most of the growth in consumption will likely continue to be in the developing world. North America and Europe are relatively mature markets. Demand has been decreasing in West Europe, including France where consumption has been declining since the early 1990s. In the United States, potash demand has been relatively stable, reflecting the slow growth of fertilizer consumption in recent years. Potash demand in the US will be affected by planted areas and crop mix. Potassium consumption is expected to continue its progression in the Asian countries and Latin America and a partial and gradual recovery is anticipated in the countries of Central Europe and the CIS. Growth areas are mostly in Asia and Latin America.

Between 2000 and 2005, the world consumption of fertilizer potash is projected to increase by 3.2 Mt K_2O to reach 25.1 Mt K_2O by 2005/06, equating to an annual growth rate of 3% (**Table 6**). This compares with an annual rate of 2.7% for nitrogen and 4.2% for phosphate.

Table 6 : World Fertilizer Potash Consumption: 2000-2005

Mt K_2O	***2000***	***2005***	***Annual growth rate 2000-2005***
World	21.9	25.1	+3.0%
Developing Countries	11.3	13.7	+4.3%
Developed Countries	10.6	11.4	+1.5%
Share of developing countries	52%	54%	

In several developing countries, the adoption and implementation of balanced fertilization offers positive prospects for potash consumption.

For example in India, fertilizer use in 2000 declined by 1.4 Mt nutrients, affecting the N : K_2O ratio, which suffered a setback to 100 : 13 from 100 : 15 in 1999. In the short term, given normal weather conditions, fertilizer demand is expected to recover and reach 18.5 Mt, of which potash contributes 1.75 Mt. This recovery in demand by 2001 would lead to an improvement of the N : K_2O ratio to reach 100 : 15. For 2005, overall fertilizer consumption has been projected by the Fertiliser Association of India in May 2001 to reach 22.3 Mt. By 2005, potash consumption in India is forecast at 2.1 Mt K_2O, resulting in a more balanced N : K_2O ratio of 100 : 16. For China, IFA's forecast for K_2O consumption by 2005 is close to 4.0 Mt K_2O. This projection would equate to an N : P_2O_5 : K_2O ratio of 100 : 39 : 16, which is still below the level of 100 : 43 : 22 that has been proposed by Chinese agronomists. The forecast consumption, on the basis of a more balanced fertilization scenario, would translate in potash fertilizer demand in China increasing by an additional 2.0 Mt K_2O through 2005.

World Potash Trade

World potash trade in 2000 amounted to about 20.4 Mt K_2O compared with 17.7 Mt K_2O in 1990 (**Table 7**). The main exporting countries in 2000 were Canada (41% of world trade), the CIS (27%), and the Near East (13%).

Major importers are the United States (23% of total imports), followed by China with 15% and Brazil with 12%.

Potassium Supply and Demand Balance

Between 1995 and 2000, the world potash capacity increased by 2%, resulting in a net addition of 0.7 Mt K_2O. The production capability rose by a net 3.4

Table 7 : World Potash Trade (2000)

Exporters	*Exports Mt K_2O*	*World Share*	*Importers*	*Imports Mt K_2O*	*World Share*
Canada	8.5	41%	United States	4.8	23%
Belarus	2.8	14%	China	3.1	15%
Russia	2.7	13%	Brazil	2.4	12%
Germany	2.7	13%	India	1.6	8%
Israel	1.5	7%	Malaysia	1.3	6%
Jordan	1.1	6%	France	0.8	4%
Others	1.1	6%	Others	6.6	32%
Total	20.4		Total	20.4	

Mt K_2O as existing operations improved their efficiencies and new operations installed readily available capacity. During the same period, potash disappearance increased by 1.6 Mt K_2O, and fertilizer potash demand by 1.4 Mt. This imbalance between total disappearance and capability expanded the existing surplus that has been prevailing since the 1980s. Closures in the USA and West Europe were offset by new capacity in the Near East and Latin America. New developments are expected in Canada, Asia and the CIS. Potash demand, after the collapse of 1989-1990, has since recovered gradually. Between 1990 and 1995, the surplus of production capability over disappearance increased by more than 50% from 3.5 Mt to 5.8 Mt K_2O. Indeed, the growth rate of the production capability was much higher than that of demand. This sustained surplus has become a persistent operating feature for the suppliers, putting pressure on the marketplace.

Developments during the past five years are summarized in **Table 8**.

Announced closures in Europe are offset by new capacities commissioned or to be commissioned between 2001 and 2005 in China, Canada, Brazil, Israel and Jordan. IFA's supply / demand assessments for potash for the period of 2000 to 2005 are given in **Table 9**.

For the next five years, the potash capacity will continue to expand, to reach 38.3 Mt K_2O in 2005, a net addition of 1.4 Mt K_2O (or 0.7% / a) over 2000. Potash disappearance is expected to grow at an annual rate of 2.6%, to reach close to 28.4 Mt K_2O. The current surplus over the production capability, at about 7.6 Mt K_2O in 2000, is projected to decline

Table 8 : Potash-World Supply/Demand (1995 to 2000)

Mt K_2O	*Year(s)*	*Potash*
Existing capacity	1995	36.2
Capacity increase	1995 to 2000	+0.7
Production capability change	1995 to 2000	+3.4
Disappearance increase	1995 to 2000	+1.6
Fertilizer demand change	1995 to 2000	+1.4
Surplus change	1995 to 2000	+1.8

Table 9: Potash Supply/Demand Balance: Forecast to 2005

Mt K_2O	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Supply/Demand Balance	+7.6	+7.1	+6.6	+6.3	+5.8	+5.6
% of production capability	23%	21%	20%	19%	17%	17%

Source: Louis, P.L. (2001).

to 5.6 Mt K_2O in 2005; this level equates to 17% of the production capability, down from 23% in 2000.

Regional Supply/Demand Balances

Major consuming regions, such as Asia and Latin America, will continue to depend substantially on imports, due to the resilient imbalance in the supply/demand situation, and the sustained growth in demand. Exporting regions such as North America, East Europe/Central Asia and the Near East will maintain and, in some cases, expand their capabilities to meet world requirements for potash in growing and emerging markets.

For the next five years, the net trade surplus from established exporters will decline marginally by 0.2 Mt to reach 19.5 Mt K_2O, with Canada and the CIS responsible for about 78% of this amount (**Table 10**). The trade deficit of the net importing countries will increase by 11.2% (or 1.5 Mt K_2O) to reach about 14 Mt by 2005. Major importing regions will remain Latin America (mainly Brazil) and Asia. The supply

Table 10 : Regional Potash Supply/Demand Balances (2001-2005)

Mt K_2O	***2001***	***2005***
West Europe	+1.4	+1.2
Central Europe	–0.9	–0.9
East Europe, Central Asia	+7.5	+7.4
North America	+7.9	+8.1
Latin America	–2.9	–3.3
Africa	–0.5	–0.5
Near East	+2.7	+2.8
Asia	–4.3	–5.0
Socialist Asia	–3.5	–3.8
Oceania	–0.4	–0.4
World	+7.1	+5.6

deficit in Latin America is projected to increase by 13.8% to reach 3.3 Mt K_2O. A significant increase of the trade deficit will occur in Asia: in South, North and East Asia it will reach 5.0 Mt K_2O in 2005, 16.3% more than in 2000. In Socialist Asia, notably China and Vietnam, the potash trade deficit will expand from 3.5 Mt to 3.8 Mt, equating to an 8.6% increase over 2000.

The global demand for potash fertilizers remains strong in the near term. Further closures are not anticipated to affect the market place due to the offsetting effects of new capacity. The world potash market has shown its resilience to exist with a sustained surplus over the past 20 years. The declining surplus, associated with a sustained growth in demand, would provide some comfort for suppliers in the near term.

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