Current World Potash Situation & Future Outlook

H. Magen, IPI; ipi@ipipotash.org

Abstract

Between 1992 and 2008 global potash consumption steadily increased at a higher rate than that of nitrogen, resulting in an improved K:N ratio and reversing the trends of recent decades. The main reason for this is the change in diets in regions with high population growth, where there is an increased demand for meat, vegetables, fruits and vegetable oils. For example in China, during the later 1990's, 38% of potassium was used for the production of vegetables and fruits (FAO, 2002). However, according to a recent assessment (IFA, 2009), this has now increased to 50%.

Freeman (2009) estimated that between 2002 and 2007, China, India, Brazil, Malaysia and Indonesia consumed almost 80% of the potash used in developing countries, and 50% of the global K consumption. In an earlier analysis (Magen and Imas, 2006), IPI estimated that during the last 15 years the global increase in production of vegetable, fruit and oilseed (mainly soybean and oil palm) accounted for approximately 50-60% of the additional annual requirement for potash. Indeed, there is an overlap between these crop sectors and the regions cited as the major potash consumers.

Will the trend of steadily increasing demand for potash continue? While consumption in 2009 is far below that of 2008, the underlying factors affecting potash consumption have not changed, and are similar to those that have prevailed during the last two decades. According to the FAO (2002), the additional calorie intake in 2030 in developing countries will be mainly provided from wheat, vegetable oils and meat; crop production in 2030 will achieve an improvement of approximately 30% more than in 1997-99. In addition, harvested land will also increase, particularly for crops such as maize, sugarcane, soybean and groundnut. All these emphasize the need for efficient fertilization practices to sustain this growth.

Additional demand for food, feed, fiber and biofuel, as well as the demand for better quality food, will impose significant pressure on natural resources, such as land and water, and require more efficient crop production. Cereal-based cropping systems may also change, with maize rapidly increasing its share. Based on future crop production, cropping systems and patterns of fertilizer use, we estimate that the majority of future potash consumption will be divided equally between cereals, fruit and vegetables, and oilseeds.

Past and actual potash consumption

Potash consumption can be divided into three phases: 1960-1988, 1988-1992, 1992 till today. In the first phase, potash consumption increased steadily, but to a lesser extent than that of N and P, leading to a decline in the K:N ratio (Fig. 1). This period is characterized by the vigorous increase in cereal production. The second phase (1988-

1992) describes potash consumption, which correlates with the sharp decrease of potash consumption in the FSU countries and Central Europe. The third phase (1992-2008) describes a steady increase of potash consumption over sixteen years, at a higher growth rate than that of N, leading to an improvement in the global K:N ratio (Fig. 1). This period is characterized by a strong increase in the production of oil seeds, vegetables and fruits, and sugar - all heavy K-demanding crops.

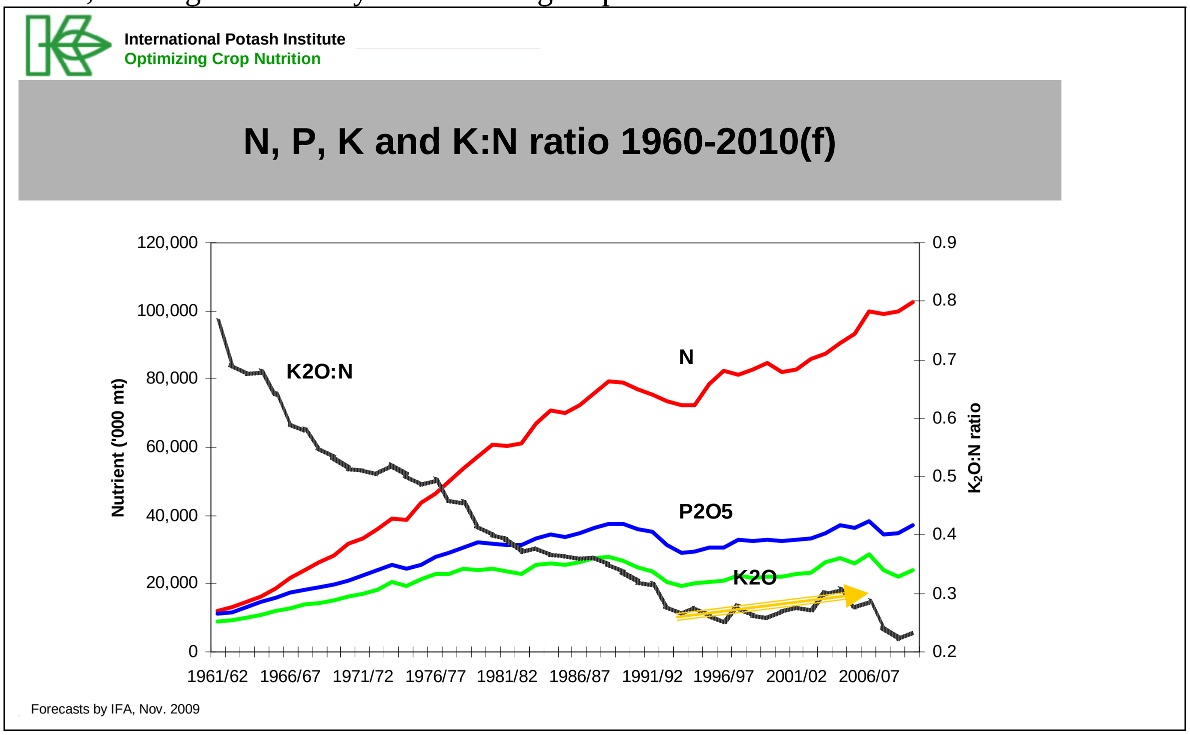

Fig. 1: N, P_2O_5 and K_2O consumption and short term forecasts and calculated K:N ratio 1962-today (source: FAO, IFA)

During 1990 to 2007, cultivation of arable land has marginally increased by 7 million hectares (FAOSTAT, 1-2010). Furthermore, farmers around the world have also shifted from less profitable staples to higher-value crops. Two major crop groups have had the greatest impact: cultivation of oil crops has expanded by more than 70 million hectares, of which half has been soybean (mostly as newly cultivated land). Fruit and vegetable crops have increased by more than 35 million hectares, with more than half of this growth occurring in China (as cereal production has been converted to horticulture; Fig. 2). Freeman (2009) estimated that during 2002-2007, China, India, Brazil and Malaysia and Indonesia accounted for almost 80% of the potash consumption in developing countries, an analysis that overlaps the agricultural growth described. Magen and Imas (2006) also estimated that the increased global production of vegetables, fruits and oilseeds (mainly soybean and oil palm) accounts for approx 50-60% of the additional annual requirement for potash during the last 15 years.

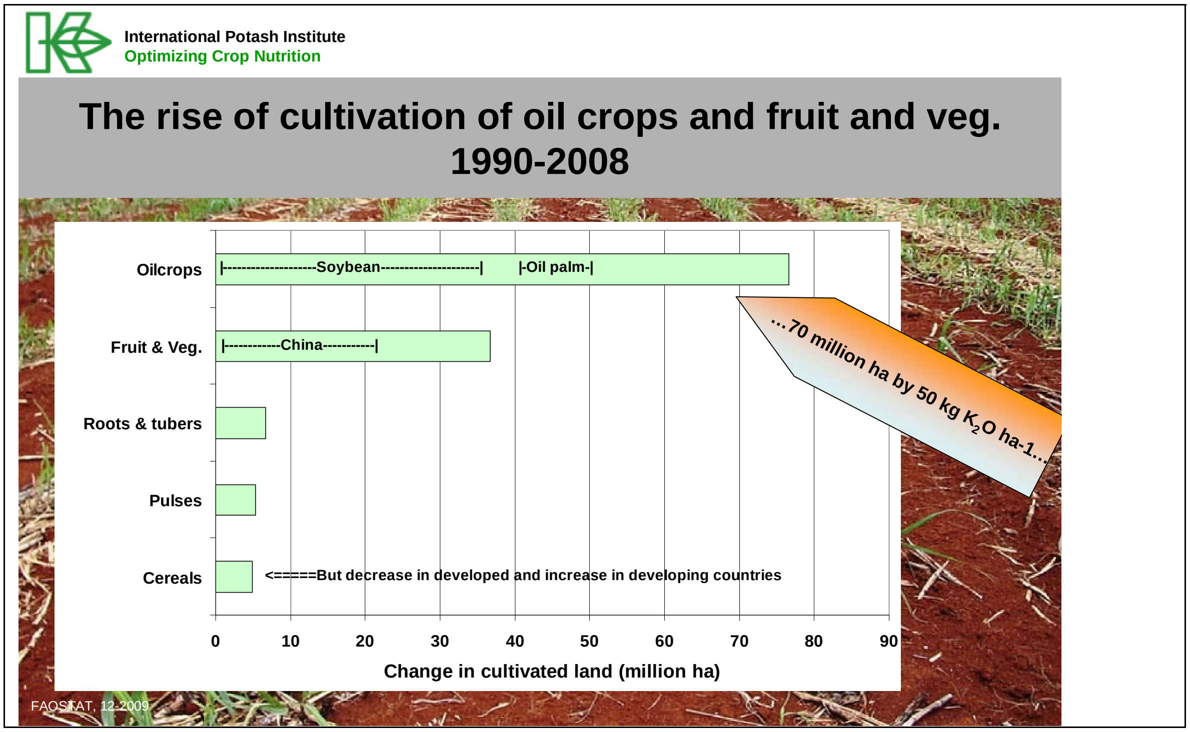

Fig. 2: Changes in cultivated land between 1990 and 2008 (FAO)

Sub-optimal application of potassium – still widespread phenomena

Negative K balance (K removed > K inputs) is found in many cereal cropping systems, beans, millets, grasslands and other staple crops. Ladha *et al*. (2003) reported that in 33 long-term fertilizer experiments in rice-wheat cropping systems, 94% were found with negative K balance and 85% with negative K balance as high as 70-170 kg K ha^{-1} $year^{-1}$. Further, the authors conclude that negative K balance appears to be the general cause for yield stagnation and decline in many of the sites reviewed in this research.

Öborn (2009) shows that the long-term (11 years) K balance in grassland is highly negative even when applying 66 kg K ha^{-1} $year^{-1}$, as the K removal is greater to the K applied. The detailed K balance calculation used brings into account also deposition of K (1.4 kg K ha^{-1} $year^{-1}$) and leaching (0.8-2.3 K ha^{-1} $year^{-1}$).

In field experiments conducted in north-east China (Niu *et al*. in press), we demonstrate K balance in maize at seven locations under different management practices at three levels of potassium (Fig. 3). In all locations, zero application of potassium led to a negative balance of 100-300 kg K ha^{-1} $year^{-1}$, being reduced to 10-60 K ha^{-1} $year^{-1}$ with K application. High yielding practices (seeding rate, varieties, tillage) presented, in general, more sensitivity to K balance.

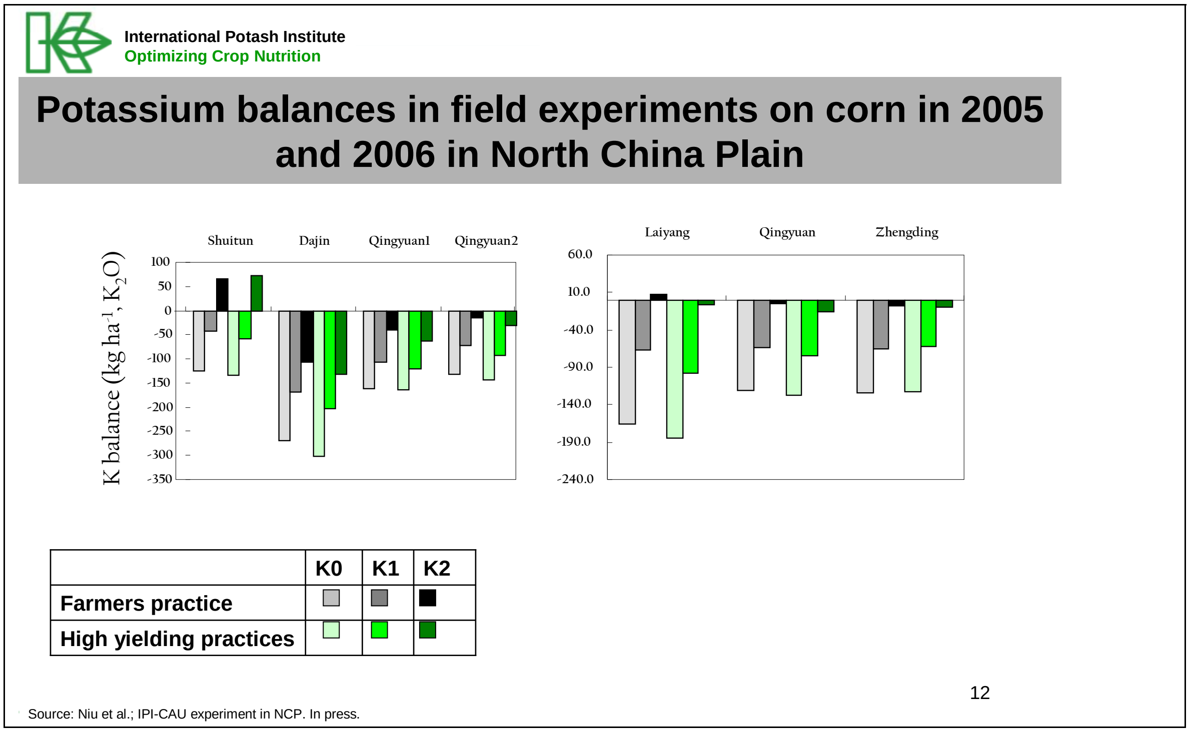

Fig. 3: K balance in maize at seven locations in north-east China, under different management practices at three levels of potassium.

Typically, omission or insufficient K application causes a decline in K levels in the soil and thus reduces fertility. The depletion process takes a few years, and therefore, under specific conditions and optimal K application levels, no loss in yields is anticipated in the first year(s) after omission of K fertilizer. In a five-year field experiment on a light textured soil in Haryana, India, we tested K levels in soil under a several levels of K application (0-60 kg K_2O ha^{-1} $year^{-1}$). With low level of initial available soil K (85 ppm), all treatments suffered from reduced available K in soil, although this was most noticeable in the treatment with no K (K=0), which declined from 85 to 67 ppm available K during the five year period. Other treatments showed a similar trend (Fig. 4). Our experiment shows that moderate levels of potassium applied do increase yield and thus removal of K, if not sufficiently supplied, will result in a negative K balance causing a decline in fertility.

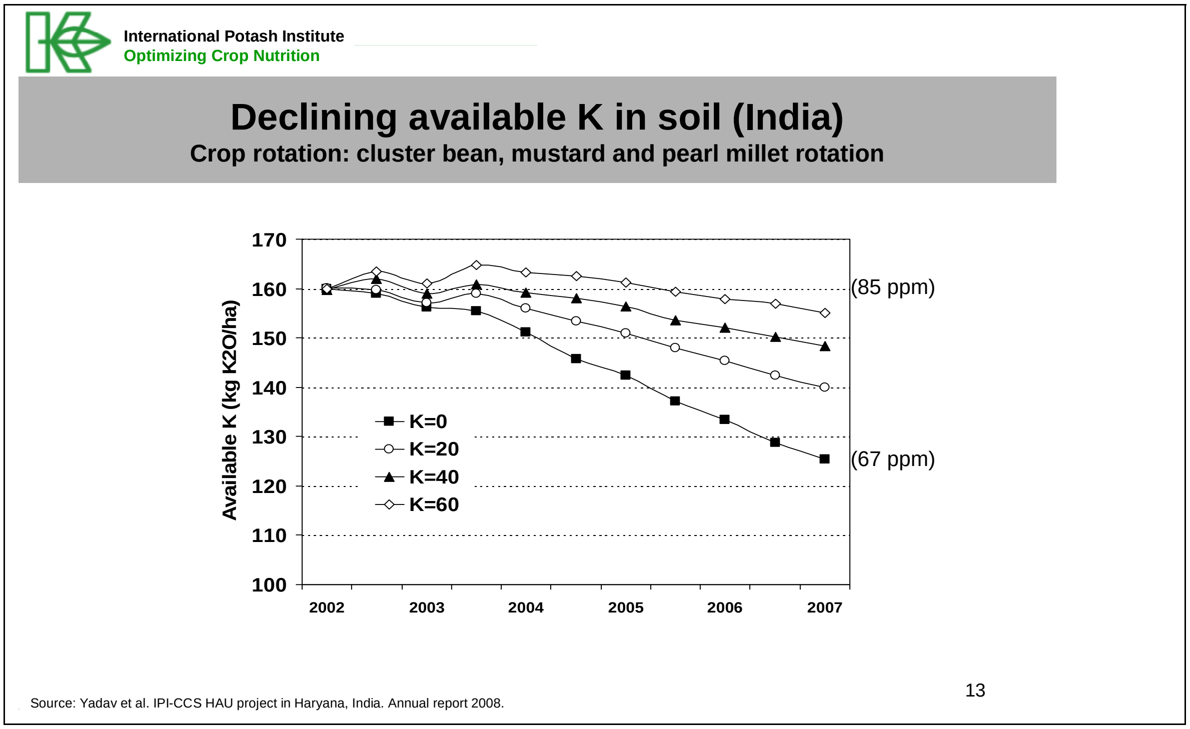

Fig. 4: Decline of soil available K after different K application levels in cluster bean-mustard-pearl millet crop rotation, Bawal, Haryana, India (Yadav, 2008).

Future changes in cropping systems may present additional inputs to the calculation of K balance, and these need further attention (Buresh, personal communication): i) rice in Asia is receiving significant amounts of K with irrigation water. However, water-saving and aerobic rice will significantly reduce this input; ii) inclusion of maize in rice cropping systems will increase the annual DM production and hence K uptake; iii) maize crop residues are typically not returned to the field, and hence aggravate K removal from the field. All these developments will put more stress on K balance and this needs to taken into account when providing appropriate, suitable K recommendations.

Future requirements of potash

Future demand for food is enormous and the limited availability of land and water, climate change and the need to adhere to environmentally-friendly practices – all present a huge challenge to the world's agriculture in the coming years.

By 2050, the FAO forecasts that production of wheat, rice and coarse grain will increase by 32, 13 and 39%, respectively, and that of meat, milk, oil crops and sugar by 65, 70 and 120 and 125%, respectively (FAO, 2006; this calculation is based on 2008 as the base year, while in the original report the base line is the average of 1999-2000-2001). Among the oil crops, the forecast for 2050 (FAO, 2006) is that its production will more than double by 2050, with soybean and oil palm providing the highest increase (Fig. 5). This crop sector presents one of the highest growth rates in the future; the sugar sector may significantly increase as a result of the rapid expansion for biofuels.

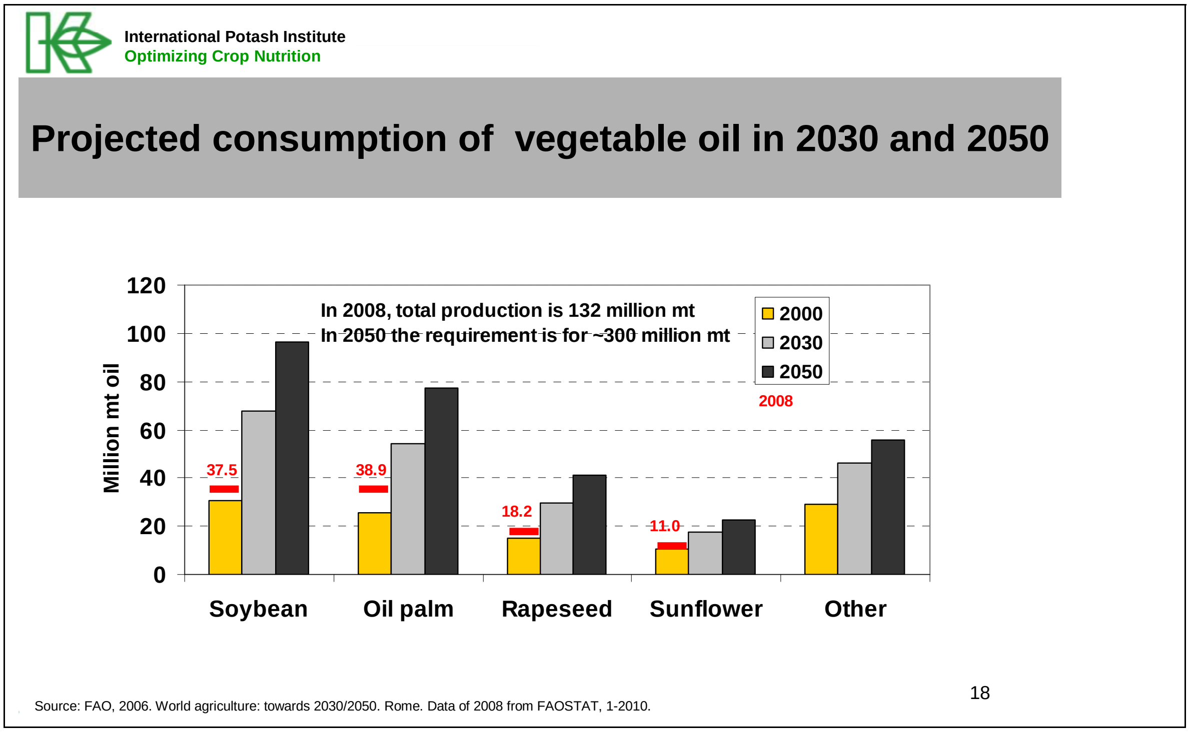

Fig. 5: Projected consumption of vegetable oil in 2030 and 2050, with 2008 actual production. (Source: FAO, 2006 and FAOSTAT 1-2010).

In terms of land use in developing countries, FAO (2002) projects that in comparison to the land use in 1997-1999, soybean area will increase by 25 million ha by 2030, and that of maize by 20 million ha. Crops like rice and wheat will grow marginally.

Hence increased production will be achieved by both increased productivity and additional land under cultivation. In both scenarios, increased consumption of nutrients is inevitable. IPI calculations of future demand of potash are based on FAO food demand forecasts and IFA's assessment on fertilizer use by crop (IFA, 2009). Another approach for verification is used in comparing K:N ratio under different scenarios of N requirements.

According to the report made by IFA, in 2007, K consumption was split between 37% in cereals, 22% for fruit and vegetables, 16% for oil crops, 9% for sugar crops and 16% in other crops. By using the same requirement of potash per ton product, multiplied by the projected production, relative K use in 2050 is calculated (Table 1). Future relative importance of fruit and vegetable and oil crops sectors in potash consumption is significant. Both will consume approximately 50% of K, while the relative K consumption of cereals will be less than 2007. According to these assumptions and calculation, in 2050 cereals will be still the largest consumers of K (17 million mt K_2O), followed by fruit and vegetables (15 million mt K_2O) and oil crops (12 million mt K_2O). Sugar crops will double their K requirements to 5 million mt K_2O, and total estimated annual consumption may reach approximately 50 million mt K_2O.

Table 1: Relative use of potash by crop in 2007 (IFA, 2009) and calculated for 2050 (IFA, 2009 and FAO, 2006).

Crop	K use 2007	K use 2050
	% of total K consumed	
Cereals	37	31
Fruit and vegetables	22	27
Oil crops	16	22
Sugar crops	9	9
Other crops	16	11

Another approach for estimating K requirement is by using the ratio to nitrogen use (K:N ratio). Nitrogen fertilizers are a key factor for the projected growth of agricultural production, and scientists have made varying estimates for its consumption in 2050, ranging from 135 million mt N year^{-1} (Galloway et al., 2005) to 236 million mt N year^{-1} (Tilman et al., 2001). By using the same pattern of N consumption as prevailed in 1992-2008, a linear trendline that points to consumption of 150 million mt year^{-1} in 2050 can be drawn. This figure is well in the range that Tilman et al. (2001) and Galloway (2004) projected.

Using the K:N ratio of consumption may provide another verification for future K consumption. Assuming that the weight of fruit, vegetables and oil crops in future K consumption will be greater than that of 2005, we conclude that K:N ratio will increase from 0.28 in 2005 to 0.35 (an increase of 25%) in 2050 which will require the use of approximately 50 million mt of K_2O year^{-1} (Table 2), a similar figure to that obtained by calculating current K consumption and assessing its requirements by the growth of future crop production.

Table 2: Hypothetical potassium consumption scenarios in relation to N consumption in 2050.

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Hypothetical potassium consumption scenarios in relation to N consumption

	N	P_2O_5	K_2O
Nutrient consumption in 2005 (million mt)	97.9	37.6	27.1
K:N ratio 2005	1		0.28
Projected consumption in 2050 (million mt)			
Nitrogen	150		
Potassium scenario 1: NK ratio 1:0.28 (as in 2005)			42
Potassium scenario 2: NK ratio 1:0.35			52

26

Some words of caution are also required. Efficient use of nitrogen fertilizers is a prime issue for many research groups, and it will be of no surprise when specific GMO or new fertilizer products emerge in the markets. It is not clear though how this will impact on the use of K, and P. Nevertheless, a growing population and the desire and need to consume better food will significantly influence and require additional potash consumption in future.

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