Optimizing Crop Nutrition

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Editorial

Dear Readers,

Maize is now used in large quantities to fuel the bioethanol industry in the US. This, accompanied by a strong demand for animal feed, has brought prices of maize to new heights. As food imports become more and more costly, countries in Southeast Asia are looking to improve productivity of their grain production. Our project titled **"Site-specific nutrient management in maize"**, an initiative of IPNI and IPI, is described in detail in the Research Findings of this issue. This is a natural continuation to the scientific approach applied in rice (see the detailed report in *e-ifc 10*, December 2006). In these articles, you will find data on maize production in Asia and global demand, the principles of SSNM in maize, analysis of yield potential and yield gaps of maize in Southeast Asia, ways for improving the productivity of maize, and more. A section on farmer participatory development and evaluation of locally adapted nutrient management practices is also included.

We all agree that the role of farmers is crucial for productive and sustainable agriculture. In fact, the human factor is the only cohesive element in bringing together soil and climatic conditions, appropriate use of water and crops, and the optimizing of agricultural production systems. In India, farmers who achieve high yields and become financially strong are called "progressive farmers" Frankly, this appears to imply that there are "non-progressive" farmers. I do not believe that. Farmers are very much alike around the world, but the systems that surround them are quite different; whether it is the investment in research and extension, the salary paid to their advisors, or the subsidies and safety nets that support them. These factors are all crucial for successful agricultural production systems and those who work with them. In this manner, we should rather evaluate "progressive agricultural systems" to describe the complete set of parameters that affect the performance of a given system.

At the start of a new year, we look to the prospects of 2008. We wish our readers timely and sufficient rains, optimum climatic conditions, relatively few attacks of pests and disease, and - at the end of the process - good market prices. A fertile year to one and all.

Prof. Zheng Sheng Xian, Institute of Soil and Fertilizer of Academy of Agricultural Sciences in Changsha demonstrates the effect of K application on the panicle size of rice. IPI-ISSAS Nanjing experiment in Changsha. Left, zero K; right, 60 kg K_2O/ha. Photo by H. Magen.

I wish you all an enjoyable read.

Hillel Magen

Director

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I IPI field experiments in Central Europe - an overview on 15 years of activity

By Dr. T. Popp, IPI Coordinator Central Europe.

Introduction

IPI's promotional activities started in Central Europe in the late eighties. The first years were spent mainly in getting to know the agricultural structure and situation in the countries and in making contact with scientists and research institutes. The earliest field trials were established in 1993 and sugar beet and white cabbage were the crops tested in the Czech Republic and Poland. Very soon all other Central European countries were also involved in field trial projects, so that today these activities stretch from Poland in the north to Bulgaria in the south (see map). Over the years 248 experiments using 17 different crops have been carried out, by far the most with potassium demanding crops like sugar beet, maize, potato and oilseed rape (Table 1). From all this work the results of many trials are now available demonstrating the positive effect of balanced nutrition with potassium on yield and quality of field crops.

During the last two to three years the focus of research activities has been concentrated more on specialty crops like gooseberry, poppy and cherry. Most of the earlier trials dealt with different application rates of K and the effect on yield, so that a typical field trial with sugar beet had three treatments with 80, 160 and 240 kg/ha K_2O, together with the control without potash application. At the beginning - fifteen years ago - it was difficult to show any effect of potassium, because most of the soils were rich in K as the result of heavy potash applications made in previous years. However, after 1990, because of the hardship brought about by economic changes, farmers in the region stopped applying potassium completely and it did not take long until soil reserves were greatly depleted and field trials were clearly demonstrating the need for potash. Over the years the number of trial using more and more different crops increased as did the selection of sites with varying soil and climatic conditions.

After this first campaign with different rates of application, other topics became more important. These included queries such as the most suitable form of potash for a certain crop and when the application should be made, whether in autumn or spring. It also became of interest as to how the different K rates influence the composition and quality of a crop, e.g. the effect of K on the pectin content of gooseberry or on the morphine content of poppy. The latest research project focuses on the potassium uptake of different rootstocks of cherry trees. All the results from the many trial projects are used in seminars, field days, workshops and conferences to broadcast the message of balanced nutrition with potassium for sustainable agriculture. They are also part of the many publications, which have appeared in the various languages of the Central European countries. A visit to IPI's website www.ipipotash.org will provide an overview of this selection.

Table 1. Number of IPI field experiments and trials with various crops.

Crop	No. of field experiments	Crop	No. of field experiments
Sugar beet	86	Gooseberry	4
Maize	40	Strawberry	3
Potato	35	Poppy	3
Oilseed rape	27	Capsicum	2
Grape wine	17	Carrot	2
Sunflower	11	Sweet corn	2
Cereals	9	French bean	1
Cherry	4	Onion	1
		Cabbage	1

Map of IPI activities in Central Europe. The green boxes indicate the number of field experiments conducted (see also by crop, in Table 1).

Results from experiments

A few examples of the many trial results are discussed below.

Omission plot trial on a crop rotation in Romania

A classical crop rotation with maize, sunflower, spring barley and winter wheat was the basis for this trial. Besides a control without application of nutrients, two levels of full NPK treatment, adjusted to the needs of the crops were compared with omission plots of NP, NK and PK (Fig. 1). The results show that the higher application rate of NPK and the corresponding omission plots did not result in a significant higher yield, yet it improved yields (calculated as cereal units). However, omission of K (the NP treatment) resulted in decline of total cereal units of 8.6-13.2%, greater loss than that with the omission of P (the NK plot). Clearly, omission of N caused severe overall yield reductions. The results also suggest that at higher levels of nutrient application, the omission or short supply of a nutrient may cause higher losses.

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Nitrogen-potassium interaction in sugar beet, Poland

First of all it is impressive to see how sugar beet positively responds to potassium fertilization even without any application of nitrogen (N=0; Fig. 2). At both N=90 and N=150, K application increased yields and brought higher returns for the nitrogen applied. Based on the results of this three-year field trial, the optimum fertilizer strategy was shown to be the application of 90 kg/ha N and 240 kg/ha K_2O.

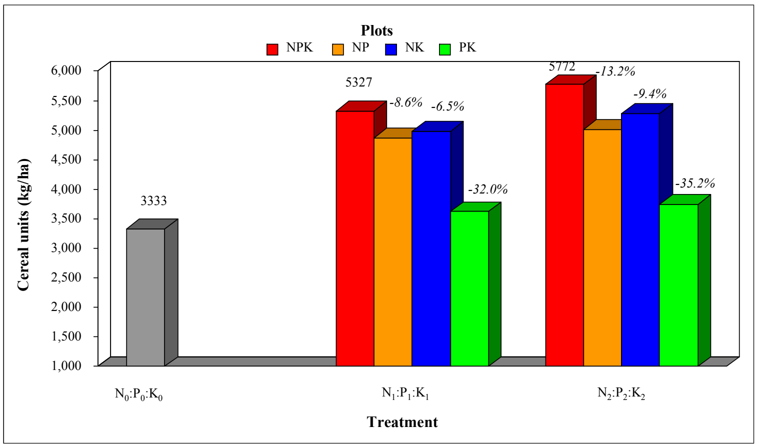

Fig. 1. An omission plot trial in a crop rotation (maize - sunflower - spring barley - winter wheat) in Livada, Romania, 2004-2007. Results are an average of four years.

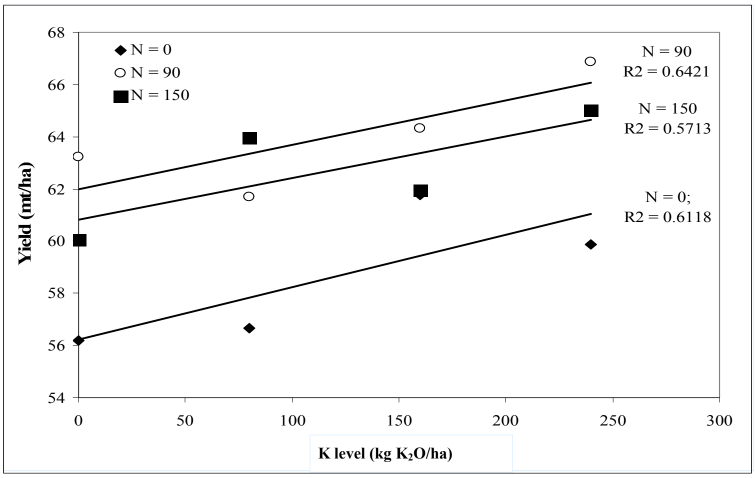

Fig. 2. Nitrogen and potassium interaction on yield of sugar beet in Koscian, Poland, 2000 – 2002. Results are the average of three years.

Depot fertilization in maize, Croatia

Amelioration fertilization on very K-deficient soils is a practical solution in many cases. At the site in Croatia described here, 500 and 1,250 kg/ha K_2O as MOP were applied in the spring of 2001 to a maize hybrid crop. The response to K application was monitored in 2001, and in 2002-2004, the residual effect of this applied K was observed (Fig. 3).

The yield response in 2001 to the depot K fertilization was more than 9.4% and 14.4% for the 500 and 1,250 kg K_2O/ha, treatments respectively (Fig. 3). In 2002, depot K application was very beneficial, as it improved yields by 16.4 and 23.5% for the K applied. In 2003, poor climatic conditions prevented high yield, nevertheless, the depot K was still affecting yield (+11.9 and +8.5 for the 500 and 1,250 kg K_2O treatments respectively). In 2004, there was virtually no yield response to the K applied in 2001.

It can be concluded that in these soils, a depot application of MOP has a positive effect on maize yields in the year of its application and improved yield for the next two years after application.

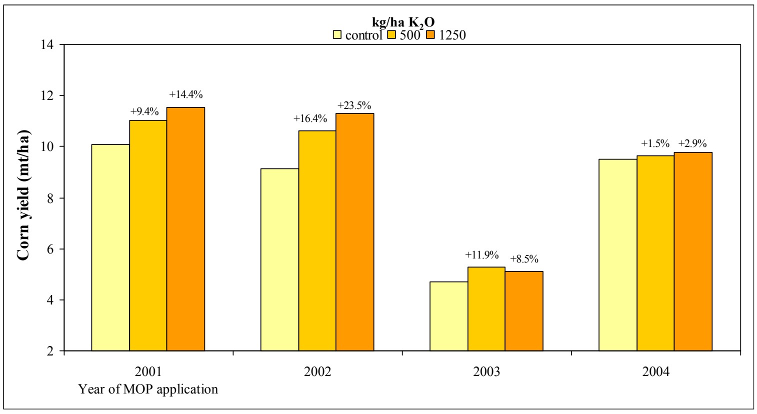

Fig. 3. Residual effects of MOP fertilization in spring 2001 on grain yield of corn hybrids on K-deficient soil in Gundinci, Eastern Croatia (total of 20 trials using five hybrids at the same location over four years).

Potassium effect on potato, Hungary

This classical trial project with increasing K application rates took place in Tornyospálca, Eastern Hungary, during 1998-2003. The results demonstrate the efficient transformation of available potassium into yield of potato. Almost 5 mt/ha higher yield could be achieved with 240 kg/ha K_2O compared with the NP fertilized control (Fig. 4). This trial was carried out in the eastern part of Hungary on a sandy soil, where water supply is often a limiting factor. It is assumed that potash application was also serving as a

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"drought insurance" against dry spells (see also the report on K and drought in *e-ifc* 12, at http://www.ipipotash.org/e-ifc/2007-12/research3.php)

To summarize the success story of field trial projects in Central Europe, it has been demonstrated on many occasions that potassium is a very limiting nutrient in the region. Not only of importance are the increases in crop yield that are often obtained. More and more the farmers' focus is turning to improvement of quality of crops such as increased sugar or oil content, more colorful apples, better tasting strawberries and higher quality wine. This is to be expected as most of the countries of Central Europe are members of the EU, in which crop quality aspects are likely to play a major role in the development of agriculture.

Our program in the region responds to these expectations: Potassium plays a pivotal role in the quality of agricultural products, and Central Europe Coordination is striving to demonstrate this to the many farmers in the region.

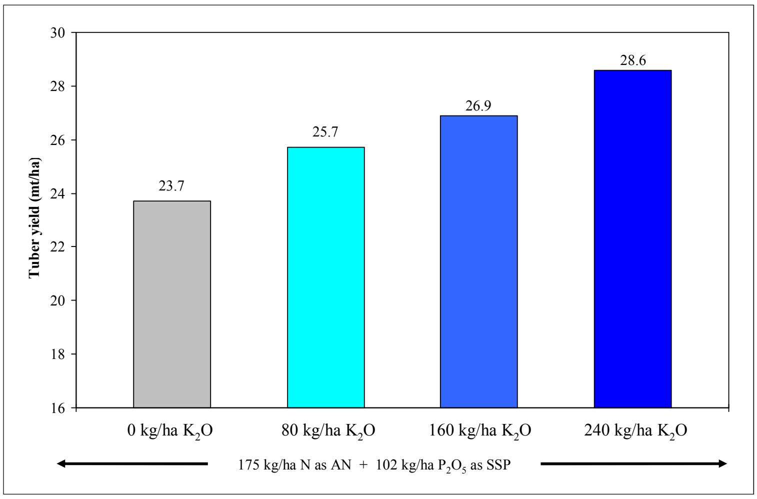

Fig. 4. The effect of different application rates of potassium on yield of potato in Tornyospálca, Hungary. Results are average for yields in 1998 and 2000-2003.

Dr. T. Popp, IPI Coordinator in Central Europe.

Dr. Thomas Popp *was born in Stuttgart, Germany. He joined the Agricultural University of Stuttgart-Hohenheim and finished his diploma in 1978. He got his PhD from the Technical University Munich-Weihenstephan, where he did his thesis at the Institute of Grassland Science based on aerial photos from the years 1917, 1953, 1960 und 1974. Topic of the thesis: "Changes in land use and development of soil erosion in parts of the Bavarian Alps since 1917". In 1983 Dr. Popp joined BASF and became responsible for technical advisory service in Asia and the Pacific. In 1987 he moved to Kuala Lumpur und served the region from there. After returning back to Germany in 1990 Dr. Popp was initially more involved with advisory service for the German market, but in the mid nineties he became responsible for Asia as technical advisor. In 1999 he got another overseas' posting, this time in Singapore, where he spent three years. With his return to Germany in July 2002 he left the nitrogen industry and joined K+S KALI GmbH. Since then he is serving the countries in Central Europe as advisor for potassium and magnesium. Dr. Popp is also acting as IPI Coordinator for this region.*

Kalium, Potassium - 200 years ago

2007 marks the 200th anniversary of the discovery of potassium. On the 19th November 1807, Sir Humphry Davy, an English chemist, presented his discovery of metallic potassium in the Bakerian lecture at the Royal Society of London. Sir Davy discovered several chemical elements (including sodium and boron) and compounds, and became one of the greatest exponents of the scientific method. He is also known for his invention of a miner's safety lamp.

Potassium was extracted from plants, and the term 'al-qali' is 'ashes' in Arabic. Sir Davy named the element Potassium in 1807.

See more in:

http://www.bbc.co.uk/history/historic_figures/davy_humphrey.shtml

http://chem.ch.huji.ac.il/history/davy.htm

http://elements.vanderkrogt.net/elem/k.html

Source: http://chem.ch.huji.ac.il/history/davy.htm

Research findings

II Maize in Asia and the global demand for maize

By Dr. C. Witt and J.M.C.A. Pasuquin, IPNI-IPI Southeast Asia Program, Singapore.

Corn farmer in the Philippines. Photo by Dr. C. Witt.

Maize is the second most important cereal crop after rice in Asia. It is the substitute staple for people in the rural areas and mountainous regions, especially during periods of rice shortage. Maize is also the primary source of feed for the poultry and livestock industry as well as a source of raw material for the manufacturing sector, and is therefore an important source of income for many Asian farmers.

Asia contributes about one-third to the world's total maize production with China taking the lead both in terms of yield and harvested area (Table 1). In Southeast Asia, the total harvested area with maize is currently about 8.6 million ha (FAOSTAT 2007) with the largest areas in Indonesia (41%), the Philippines (29%), Thailand (13%), and Vietnam (12%).

The rapid adoption of high-yielding hybrid maize varieties in Asia has led to significant yield increases in the favorable rain-fed and irrigated maize growing areas. However, a systematic evaluation of current farmers' fertilizer practices and the development of more site-specific fertilizer recommendations are needed to assist farmers in their aim to increase yields and profitability in a sustainable fashion. The average national yield in Indonesia, Thailand, and Vietnam is only 3-4 mt/ha (2 mt/ha in the Philippines) and knowledge on yield potential, exploitable yield gaps, and constraints to improving productivity at the field level is still limited (Ekasingh *et al*., 2004; Gerparcio *et al*., 2004; Swastika *et al*., 2004; Thanh Ha *et al*., 2005). Current recorded average maize yields, in comparison to climatic-genetic yield potential, indicate that there is a large scope for further increasing maize production by closing this yield gap.

The average yield of maize in Asia is only 3.9 mt/ha but this includes a wide range of varieties (hybrids, open-pollinated varieties, traditional) and growing conditions, including areas with water shortage or extensive farming. In recent years, the majority of farmers in favorable maize-growing areas have switched to hybrid varieties for its superior yield and profit, despite the higher seed cost. The main limitation to achieving higher yields and associated higher profitability per unit of arable land is often the ineffective use of inputs (particularly nutrients, seed, and pesticide). Better crop, nutrient, pest, and water management practices, along with the use of germplasm with a higher yield potential, are required to ensure profitable maize production while meeting the growing demand.

The demand for maize in Asia is expected to grow in the years to come largely because of an increasing demand from the livestock and poultry feed industry as more animal protein is incorporated into the Asian diet. The rapid expansion of the biofuel industry in recent years driven by new policy developments and high fossil energy costs is also expected to have an impact on global maize demand and supply. The growing demand in the region cannot be met despite the increase in domestic production and yield of maize in the last 15 years. For example, Indonesia's maize production and yield continue to increase, and yet the country imported more than one million mt of maize annually in the last five years (Fig. 1). The United States has maintained its position as the world's most important maize trader, exporting an average of 47 million mt of maize annually (Fig. 2). After 2005, corn prices have sharply increased in the world market largely due to an increasing demand by ethanol

Table 1. Average annual maize production, area harvested, and yield in selected Asian countries, 2000-2006 (FAO 2007).

Country or Area	Production	Area harvested	Yield
	million mt	million ha	mt/ha
China	124.8	25.0	5.0
India	13.1	7.0	1.9
Indonesia	10.7	3.4	3.2
Bangladesh	0.2	0.04	4.1
Vietnam	3.0	0.9	3.3
Thailand	4.2	1.1	3.8
Myanmar	0.7	0.3	2.6
Philippines	5.0	2.5	2.0
Other Asian countries	13.0	4.2	3.1
Asia	174.7	44.4	3.9
World	655.6	142.1	4.6

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producers, but US exports continue to be strong and may remain relatively stable in the years to come (FAPRI, 2007). Despite an annual maize production of 175 million mt, Asia continues to be the biggest importer of maize, with annual imports of 42 million mt of grain valued at US$ 5.7 billion.

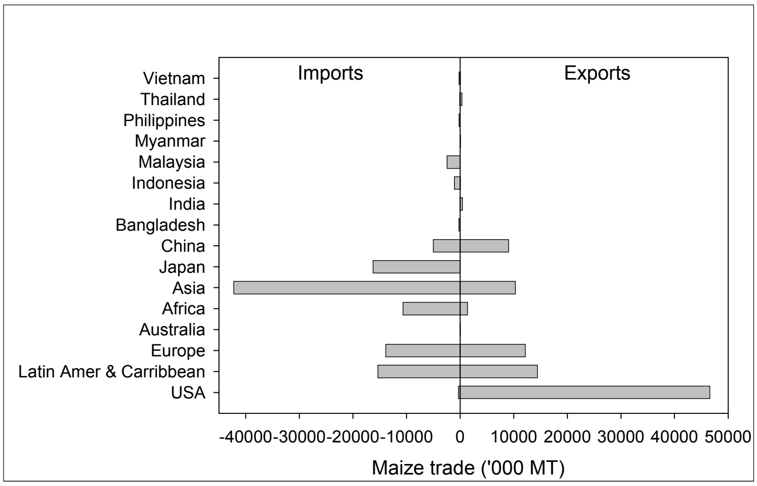

Fig. 1. Global maize trade. Data represents the average of six years from 2000 to 2005 (FAO 2007).

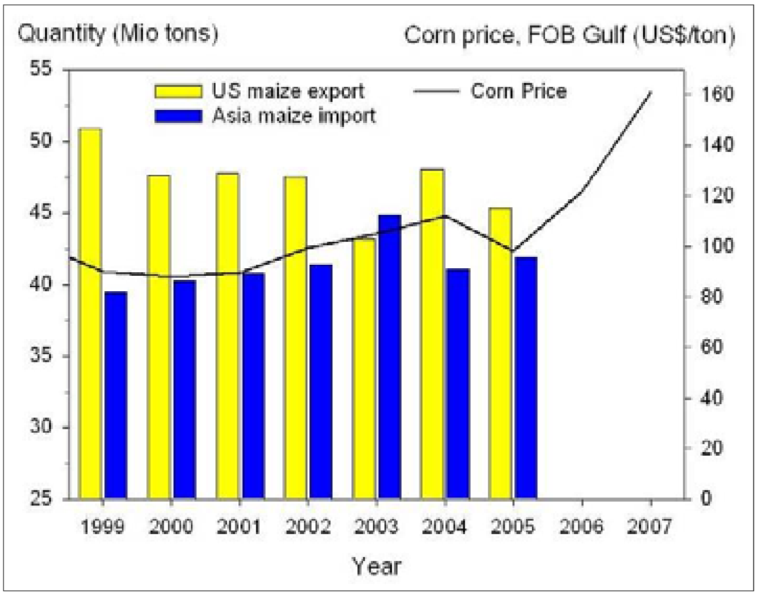

Fig. 2. Total US maize export and imports into Asia during 1999-2005 (FAO 2007) and corn prices in 1999-2007 (IMF Primary Commodity Prices, www.imf.org). In 2006/07, the US exported 56,899 million mt of corn while Asia imported 33,465 million mt (FAPRI 2007).

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Research findings

III Yield potential and yield gaps of maize in Southeast Asia

By Dr. C. Witt and J.M.C.A. Pasuquin, IPNI-IPI Southeast Asia Program, Singapore.

Quantifying the yield potential of maize at any given site is a key to understanding the existing yield gaps and identifying the most important constraints to achieving optimal yield and profit. Understanding the causes of these yield gaps allows farmers to prioritize their efforts in improving yield and profit in a sustainable and environmentally sound fashion. It also maximizes the return of investment in research and development (e.g. irrigation facilities). Yield gaps are analyzed stepwise by estimating the yield potential, the attainable yield, and the actual yield in farmers' fields (Fig. 1).

The *yield potential* (Yp) of a crop is defined as the theoretical maximum yield in any given season solely determined by climate and germplasm assuming ample supply of water, nutrients, or other yield building factors and the complete absence of yield reducing factors such as pests and diseases. Yp is commonly estimated using plant growth models.

The *attainable yield* (Yt) is defined as the yield achieved in farmers' fields with best management practices including water, pest, and general crop management where nutrients are not limiting. The attainable yield varies – like the yield potential – from season to season and year to year depending on climate. The optimal economic yield is often linked to the attainable yield. The maximum attainable yield (Yt) in any given season could be close to the yield potential, if management is excellent and weather conditions are very favorable.

For the development of site-specific fertilizer recommendations, we recommend using the attainable yield of the last 3-5 years as the yield target. In favorable rain-fed and irrigated areas, the yield target is often about 80-90% of the yield potential. In less favorable areas or seasons, this value is somewhat lower (70-80% of the yield potential).

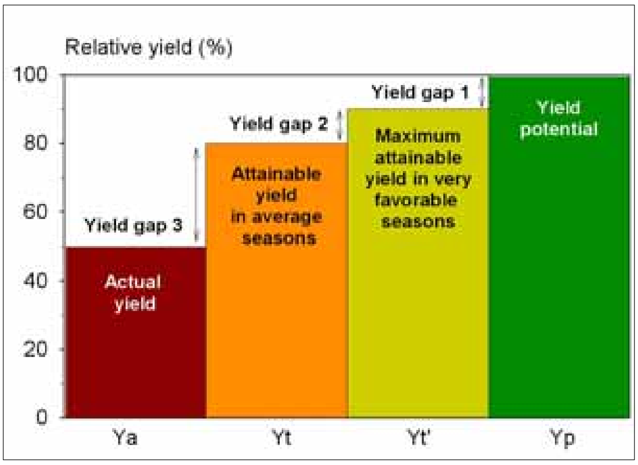

Fig. 1. Schematic overview of yield gap analysis.

The *actual yield* in farmers' fields (Ya) is often lower than the attainable yield due to constraints like water availability, pests and diseases, and poor crop and nutrient management practices.

Actual, attainable, and potential yield can be used to identify exploitable yield gaps (Fig. 1). A management objective of farmers should be to minimize yield gap 3, the difference between attainable and actual yield (Yt-Ya). To narrow this yield gap, farmers need to evaluate promising new technologies (e.g., planting density, nutrient management) that offer improvements in yield and/or productivity against current practices. Larger yield increases can be achieved when several constraints (e.g. pests and disease problems and inappropriate nutrient management) are overcome simultaneously.

Yield gap 2 is largely determined by factors that are difficult or impossible to control including the variation in climatic conditions. Best management practices such as the use of a leaf color chart (LCC) for fine tuning N management increase the likelihood of keeping yield gap 2 small.

Yield gap 1 provides important guidance in the identification of constraints. If yield gap 1 is large despite following best management practices, attainable yield must be limited by an unknown constraint. If yield gap 1 is small, there is no further room for yield improvement and efforts might focus on enhancing productivity. It is usually not economical to aim at fully reducing yield gap 1 because of the large amounts of inputs required and the high risk of crop failure and profit losses. This yield gap is smaller in seasons with very favorable weather conditions.

Estimating potential yield

The yield potential (Yp) is commonly estimated with crop growth simulation models. One such model is Hybrid-Maize developed by the University of Nebraska, Lincoln (Yang *et al.*, 2006). It is designed to provide information and better understanding of maize yield potential and the interactive effects of crop management practices and climate on maize yields. The model can simulate the growth of a maize crop under non-limiting or water-limited (rain-fed or irrigated) conditions based on daily weather data. Specifically, it allows users to:

- assess the site yield potential and its variability based on historical weather data,
- evaluate changes in attainable yield using different combinations of planting date, hybrid maturity, and plant density,
- analyze yield in relation to the timing of silking and maturity in specific years,

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- assess soil moisture status and explore options for irrigation management, and
- conduct in-season simulations to evaluate current crop status and predict final yield at maturity as a range of yield-outcome probabilities based on historical climate data for the remainder of the growing season.

Yield potential and actual yield of maize in Southeast Asia

The yield potential of maize at several locations in Indonesia, the Philippines, and Vietnam is depicted in Fig. 2. At a plant population of 65,000 plants/ha, the average potential yield varies from 10 to 16 mt/ha depending on site and date of planting. It should be noted that maize is grown under rain-fed conditions at all sites except for irrigated maize grown in Nueva Ecija in the Philippines so that it is not always possible to plant maize in a month that would promise the highest potential yield. By definition, potential yield is only determined by germplasm and climate without considering water availability. The Hybrid-Maize software offers a module to simulate water limited yield which requires a basic soil characterization including soil texture and the water content in the soil profile at the beginning of the season. However, estimates of potential yield provide a good benchmark for actual and attainable yields estimated in farmers' fields. The analysis of yield potential by planting date then offers additional information for optimizing planting dates and crop rotations in the favorable tropical environments where two to three crops including rice, maize, or wheat are grown annually.

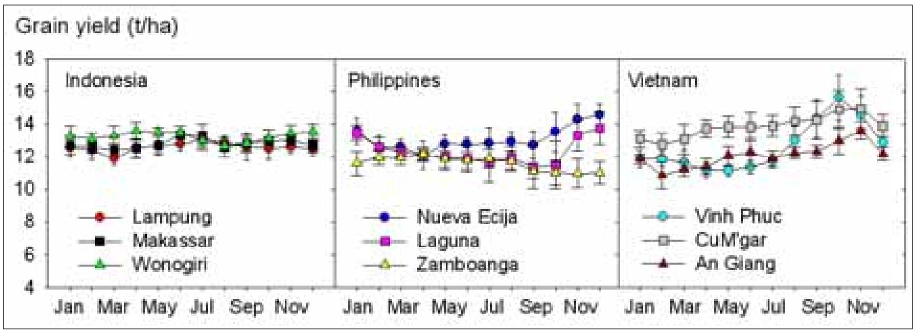
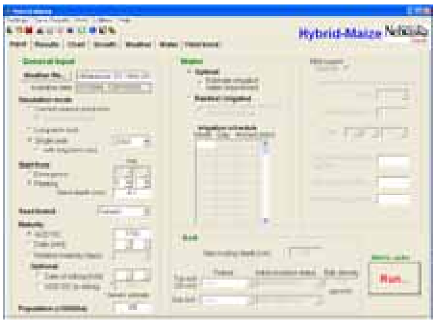


Fig. 2. Yield potential of maize as simulated by the Hybrid-Maize model for three Asian countries sown at different planting dates with a plant population of 65,000 plants/ha. Error bars are standard deviation from different sites/years of weather data (Indonesia: Lampung, 2000-2005; Wonogiri, 1999-2004, Makassar, 1994-2003. Philippines: Laguna, 1994-2003; Nueva Ecija, 1994-2001; Zamboanga, 1990-2004. Vietnam: An Giang, 1999-2005; Dak Lak, 1997-2005; Dong Nai, 1998-2005; Vinh Phuc, 1992-2002).



Start up window of the Hybrid-Rice software (Yang et al., 2006).

A comparison of actual, attainable, and potential yield for selected sites in Southeast Asia suggests substantial opportunities for Asian maize farmers to increase yield and profit (Table 1). Their average actual yields (Ya) are considerably lower than the attainable yield (Yt) with optimal crop management and ample nutrient supply. The maximum attainable yield was often close to the crop's climatic-genetic yield potential. As a general rule, optimal yield targets should probably be within 70 to 80% of potential yield in favorable irrigated or rain-fed maize environments.

Table 1. Actual, attainable, maximum attainable, and simulated yield potential of maize at selected sites in Southeast Asia, 2004-2007. Data are the average of five farms per site in at least three seasons. Attainable yield was estimated in treatments with ample supply of fertilizer N, P, and K. The maximum attainable yield is the single highest yield observed an NPK treatment at each site. The simulated potential yield was estimated with Hybrid-Maize model using actual planting densities at project sites. *Data source*: IPNI-IPI project on site-specific nutrient management for maize in Southeast Asia. Unpublished.

Site	Average farmers' yield	Average attainable yield	Maximum attainable yield	Simulated potential yield
	……………………mt/ha			…………………
Wonogiri, Central Java, Indonesia	4.9	5.7	7.3	12-14
Lampung, Indonesia	7.2	9.2	13.7	12-14
Nueva Ecija, Philippines	7.9	9.0	14.2	15-18
An Giang, Vietnam	8.3	8.8	10.3	14-16
CuM'gar, Dak Lak, Vietnam	6.2	7.8	12.0	14-15

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Research findings

IV The principles of site-specific nutrient management for maize

By Dr. C. Witt and J.M.C.A. Pasuquin, IPNI-IPI Southeast Asia Program, Singapore.

Site-specific nutrient management (SSNM) provides an approach for "feeding" crops with nutrients as and when needed. The concept was first developed for irrigated rice in Asia and has been well documented at the SSNM web site of the Irrigated Rice Research Consortium including a complete list of publications (IRRI, 2007). Since its conception and development in the late 1990s (Dobermann and White, 1999; Dobermann *et al*., 2002), SSNM has gained popularity among rice farmers, researchers, and policy makers in Asia because it offers nutrient management options that are scientifically sound yet easy to develop, communicate, and apply by extension staff and farmers.

The principles of SSNM are generic and applicable to other crops. In the presentation below we apply the principles of SSNM developed for rice (Buresh and Witt, 2007; IRRI, 2007) to cereal crops in Asia. We then summarize some of the specific recommendations from an SSNM approach for tropical maize currently under development in a collaborative project between the IPNI-IPI Southeast Asia Program and research institutes in the region.

Urea application in maize, Indonesia, 2007. Photo by Dr. C. Witt.

Generic principles of SSNM for cereal crops in Asia

In 2006, rice, maize, and wheat in Asia was harvested on about 281.5 million ha with a total cereal production of 1,050 million mt (FAO, 2007). The largest area cropped with these cereals is found in China (28%) and India (28%) with other countries each having less than 5% share of the total cereal area. The contribution of irrigated or favorable rain-fed environments to total production is significant. Irrigated rice systems provide 75% of the world's rice supply on only about one half of the world's rice land. Adequate fertilizers use in the favorable environments of Asia is therefore essential for global cereal production as yields in the absence of fertilizers are typically insufficient to meet food needs and achieve highest profit for farmers (Dawe, 2004; Moya *et al*., 2004; Buresh and Witt, 2008).

Existing fertilizer recommendations for rice, maize and wheat in Asia often consist of one predetermined rate of nitrogen (N), phosphorus (P), and potassium (K) for vast areas of crop production. Such recommendations assume that the need of a crop for nutrients is constant over time and over large areas. But the growth and needs of a crop for supplemental nutrients can vary greatly among fields, seasons, and years as a result of differences in crop-growing conditions, crop and soil management, and climate. Hence, the management of nutrients for cereals in Asia requires new approaches, which enables adjustments in applying N, P, and K to accommodate the field-specific needs of the crop for supplemental nutrients.

SSNM strives to enable farmers to adjust fertilizer use dynamically to make up the deficit in nutrient needs between that required by a high-yielding crop and nutrient supply from naturally occurring indigenous sources (i.e. soil, crop residues, manures, and irrigation water). The SSNM approach does not specifically aim either to reduce or to increase fertilizer use. Instead, it aims to apply nutrients at optimal rates and times in order to achieve high yield and high efficiency of nutrient use by the crop, leading to a high cash value of the harvest per unit of fertilizer invested.

Seven questions on SSNM

The following seven questions provide guidance in the development of SSNM recommendations (see also Fig. 1 for the experimental design of SSNM):

1. How large is the yield response (ΔY) to the application of fertilizer N, P, and K in an average season?

The yield response largely determines the total requirement for fertilizer N, P, and K to meet the crop's nutrient demand for a high yield at maximum economic return. Fertilizer N, P, and K are applied to supplement the nutrients from indigenous sources and achieve the yield target. The quantity of required fertilizer is determined by the deficit between the crop's total needs for nutrients – as determined by the yield target – and the supply of these nutrients from indigenous sources – as determined by the nutrient-limited yield.

The <u>attainable yield</u> is the grain yield for a crop grown in farmers' fields with

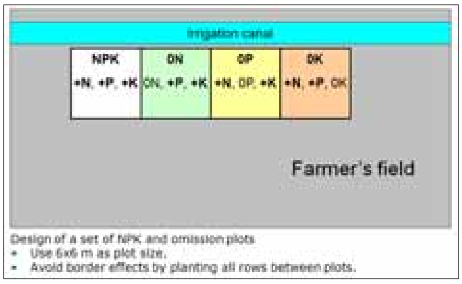

Fig. 1. Experimental design for estimating i) attainable grain yield in NPK plots, ii) nutrient limited yield in 0N, 0P, and 0K plots, iii) grain yield responses to the application of fertilizer N, P, and K (NPK – 0N, NPK – 0P, and NPK – 0K), and iv) the agronomic efficiency of fertilizer N (kg grain yield in NPK – 0N divided by kg fertilizer N).

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Researchers and farmers attending a meeting to review and discuss SSNM in maize. Bandar Lampung, Indonesia, 28 May-1 June, 2007. Photo by Dr. C. Witt.

good management practices and without nutrient limitation to yield.

The yield target is the average attainable yield across several seasons.

The nutrient limited yield is the grain yield for a crop not fertilized with the nutrient of interest but with good management and ample supply of all other nutrients from indigenous sources or fertilizer. The nutrient limited yield is an indirect measurement of the soil indigenous nutrient supply. The SSNM approach promotes the optimal use of available indigenous nutrients coming from the soil, organic amendments, crop residue, manure, and irrigation water.

High yield is a major factor contributing to high profit so that we often use the term yield target in our communication when we want to express the aim of high yield with maximum economic return.

However, yield can vary substantially in farmers' fields despite sufficient nutrient supply and good crop management from i) field-to-field, for example because of small scale variation in soil moisture, and ii) from season-to-season, for example, because of seasonal differences in climatic conditions.

Setting a yield target is only one component in developing a meaningful fertilizer recommendation, and possibly not the most important, because not all factors contributing to high yield can be controlled in every field and/or every season.

Yield responses to the application of fertilizer N, P, and K are highly variable among fields and/or seasons. The SSNM strategy for nitrogen with total N rate, split N applications, and dynamic N management using the leaf color chart (LCC) provide assurance that additional yield can be attained in years more favorable than the average.

Likewise, the SSNM strategy for P and K aims at achieving at least 1-2 mt/ha additional grain yield, if conditions for the year are favorable for markedly higher than average yields.

High, sustainable yield relates not only to the variable, short-term need for nutrients in a given season depending on the expected yield response to fertilizer application, but also the steady, long-term need for nutrient application particularly of P and K to avoid soil nutrient depletion.

2. What is the agronomic efficiency of fertilizer N (AEN) achieved in farmers' fields?

The agronomic efficiency is an indicator used for both estimating total fertilizer N needs and optimizing N management. AEN is the yield increase per unit fertilizer N applied. It is calculated as the attainable yield minus the nutrient limited yield divided by the amount of fertilizer N applied. The agronomic efficiency of nitrogen should be estimated experimentally in a few, representative field trials. Benchmark values for AEN exist for many rice, maize, and wheat growing environments. Low AEN compared to these benchmark values indicate either sub-optimal N management or yield limiting constraints other than N. Higher than benchmark AEN may indicate insufficient N supply to meet the crop's need for nitrogen to achieve high yield at maximum economic return.

3. What is the crop's nutrient need during the growing season?

The required fertilizer N is distributed in several applications during the crop growing season. This is particularly so in the tropics, to meet the crop's need for supplemental N. Fertilizer P and K are applied in sufficient amounts early in the season to overcome deficiencies and maintain soil fertility. Fertilizer K is often applied in two split applications early and near mid-season.

4. How variable is the yield response to fertilizer N, P, and K application among fields and within a few seasons?

Large variation in climate or spatial variability in soil nutrient supply determines the need for in-season or site-specific adjustments of nutrient management including the assessment of the crop's need for N using tools like the leaf color chart (LCC).

5. What is the nutrient removal with harvested products?

Grain yields are specific for location and season - depending upon climate, rice cultivar, and crop management. The amount of nutrients taken up by a crop is directly related to yield. The yield target therefore indicates the total amount of nutrients that must be taken up by the crop. Yield target and residue management therefore largely determine

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the nutrient removal with grain and/or straw and the need for maintenance application of P and K.

6. How does the attainable yield relate to the yield potential?

The yield potential is the theoretical maximum yield determined by germplasm and climate. Relating the attainable yield estimated in farmers' fields to potential yield provides an enhanced understanding of existing yield gaps and opportunities for improvement.

7. Are any other constraints to high yield expected?

High and profitable yield is only achieved when best management practices are followed including optimal planting densities and sufficient supply of all macro- and micro-nutrients either from indigenous or fertilizer sources.

SSNM for tropical maize in Southeast Asia

The following guidelines for the development of SSNM recommendations for maize are from a work in progress. Researchers have developed and successfully evaluated the concept in a collaborative regional project between the IPNI-IPI Southeast Asia Program and research institutes in Indonesia, the Philippines, and Vietnam in 2004-2007. Participatory evaluation of the presented approach is on-going with more than 300 farmers at 19 sites in these countries.

The following crucial information is needed to develop an SSNM recommendation for maize:

- An economic yield target attainable at optimal planting density in farmers' fields with good management.
- Actual yield responses to fertilizer N, P, and K.
- The expected agronomic efficiency of N.

Estimating total fertilizer requirements

The suggested total fertilizer requirements for N, P, and K are provided in Tables 1-3. Fertilizer N rates are estimated depending on the expected grain yield response to fertilizer N application and the expected agronomic N efficiency (Table 1). Note that the table is based on the assumption that the agronomic efficiency of fertilizer N is linked to the yield response to fertilizer N application that can be achieved depending on climate, bio-physical growing conditions, and management. Table 1 further provides guidelines for the timing and splitting of fertilizer N application including in-season adjustments using the standard 4-panel LCC of IRRI.

Fertilizer P and K requirements provided in Tables 2 and 3 are estimated depending on an attainable target yield and the expected grain yield response to fertilizer application. The SSNM approach advocates sufficient use of fertilizer P and K to both overcome P and K deficiencies and avoid the mining of soil P and K. The determination of fertilizer P and K requirements for maize follow in essence an approach developed for rice (Witt and Dobermann, 2004), which maintains the scientific principles of the underlying QUEFTS model (Janssen *et al*., 1990; Witt *et al*., 1999).

Table 1. Total fertilizer N requirements according to the expected yield response to fertilizer N application and the agronomic efficiency. At yield responses of < 2 mt/ha, fertilizer N is often applied in only two split applications. IPNI-IPI Southeast Asia Program. Unpublished.

Yield response to N		V – L	L	L – M	M	M – H	H	V – H
Expected yield increase to fertilizer N application over 0N plot →		≤ 2	2-3	3-4	4-5	5-6	6-7	7-8
Expected agronomic efficiency (kg grain increase/kg applied N) →		15-17	17-25	21-29	25-31	28-33	30-35	32-36
Growth stage	Leaf color	Fertilizer N rate (kg/ha)						
Pre-plant or V0	-	**30**	**36**	**42**	**48**	**54**	**60**	**66**
2nd application at V6-V8	yellow green	40	48	57	66	75	83	92
	green / dark green	**35**	**42**	**49**	**56**	**63**	**70**	**77**
3rd application at V10 or later*	yellow green	40	48	57	66	75	83	92
	green	**35**	**42**	**49**	**56**	**63**	**70**	**77**
	dark green	30	36	41	46	51	57	62
V14-VT*	green	-	-	-	25	30	35	35
Total (range based on LCC readings before V14)		**100** (90-110)	**120** (108-132)	**140** (124-156)	**160** (140-180)	**180** (156-204)	**200** (174-226)	**220** (190-250)

* Fertilizer N is only applied at sufficient soil moisture (rainfall)

Leaf color and LCC values for most hybrid maize varieties:
Yellow green: LCC < 4.0
Green: LCC 4.0 - 4.5
Dark green: LCC > 4.5

Table 2. Total fertilizer P_2O_5 requirements depending on yield target and yield response to fertilizer P application. IPNI-IPI Southeast Asia Program. Unpublished.

Yield target (mt/ha) →	5-8 mt/ha	9-12 mt/ha
Expected yield response to fertilizer P over 0P plot (mt/ha) ↓	Fertilizer P_2O_5 rate (kg/ha)	
≤ 0.5	25 – 30	30 – 35
1.0	45 – 50	50 – 55
1.5	65 – 70	70 – 75
2.0	85 – 90	90 – 95
2.5	105 – 110	110 – 115

Note: Based on a P requirement of 40 kg P_2O_5/mt grain yield response assuming an agronomic P efficiency of 57 kg grain/kg fertilizer P plus a 20% return of gross P removal with grain and straw. It is recommended to apply 100% of fertilizer P with basal application.

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Table 3. Total fertilizer K_2O requirements depending on yield target and yield response to fertilizer K application. Note that fertilizer K_2O requirements would decrease if the return of gross K removal with grain and straw exceeded 20%. IPNI-IPI Southeast Asia Program. Unpublished.

Yield target (mt/ha) →	4 – 7 mt/ha	7 – 10 mt/ha	10 – 12 mt/ha
Expected yield response to fertilizer K over 0K plot (mt/ha) ↓	Fertilizer K_2O rate (kg/ha)		
0	20 – 30	30 – 40	40 – 50
0.5	40 – 50	50 – 60	60 – 70
1.0	60 – 70	70 – 80	80 – 90
1.5	80 – 90	90 – 100	100 – 110
2.0	100 – 110	110 – 120	120 – 130
2.5	120 – 130	130 – 140	140 – 150

Note: Based on a K requirement of 40 kg K_2O/t grain yield response assuming an agronomic K efficiency of 30 kg grain/kg K plus a 20% return of gross K removal with grain and straw. It is recommended to apply 100% of fertilizer K_2O with basal application, if < 75 kg K_2O/ha. Apply each 50% of fertilizer K_2O basal and mid-season, if >75 kg K_2O/ha.

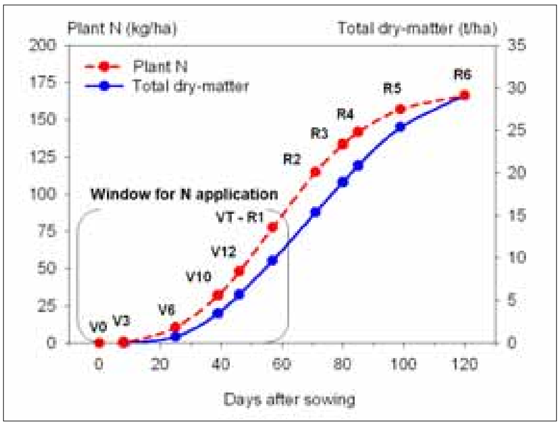

Fig. 2. Schematic overview of the plant N demand depending on growth stage. The window for fertilizer N application ranges from seeding to tasseling (VT).

Meeting the crop demand for nitrogen at critical growth stages

The demand of maize for N is strongly related to growth stage with a window for N application between crop establishment and tasseling stage (Fig. 2). In order to achieve high yield, maize plants require sufficient N in early growth to promote general shoot development, during the formation of kernel rows per ear beginning with the 5-leaf stage (V5). Likewise N is required at subsequent growth stages leading to the determination of kernels per row before tasseling (VT), and during ripening stages to enhance grain filling. The supply of N from soil and organic sources is seldom adequate for high yield, and supplemental N is typically essential for higher profit from maize fields. The SSNM approach enables farmers to apply fertilizer N in several, usually two to three doses to ensure the supply of sufficient N is synchronized with the crop need for N. An additional late N application before tasseling is recommended when high yields are expected or when N deficiency is observed as determined using a leaf color chart.

Optimize nutrient use efficiencies

Site-specific nutrient management in maize calls for flexible N management strategies that allow adjustments in N rates according to rainfall events and plant N demand using LCC. The LCC was developed for rice (Balasubramanian *et al.*, 1999; Witt *et al.*, 2005) and is also suitable for maize as indicated by spectral reflectance measurements performed on rice and maize leaves (Witt *et al.*, 2004). Detailed experiments with several maize varieties conducted at the Cereals Research Institute in Maros, South Sulawesi, Indonesia, in 2005-2006 showed that yield losses of more than 20% can be expected when LCC readings consistently fall below the color of panel four (S. Saenong, personal comment). The LCC is now being evaluated together with farmers to fine-tune N management in participatory trials with maize. The amount of fertilizer N at critical growth stages is adjusted depending on leaf color which serves as an indicator of the plant N status.

Guidelines on LCC use in maize are provided in Table 1. The time for N fertilization is pre-set at critical growth stages with adjustments in rain-fed environments to ensure sufficient soil moisture. Farmers then adjust the dose of N upward or downward based on the leaf color. The effective management of N requires adequate planting densities, good crop management, and sufficient supply of P, K, and other macro- and micro-nutrients to achieve high and profitable yield.

Planting density

Yield is closely related to planting density if other factors, such as water and nutrients, are not limiting. Under tropical conditions, there are limitations to increasing planting density because of the low yield potential due to high temperatures (compared to temperate maize) and the increased susceptibility of the crop to pests and diseases when temperatures, rainfall, and humidity are high.

Most favorable planting densities for high yield in the tropics are probably in the range of 65,000 to 75,000 plants/ha with one seed per hole to achieve a

The leaf color chart developed by IRRI for efficient N management in rice is also suitable for maize. © IRRI 2005.

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uniform crop stand. A population of less than 65,000 plants/ha is not advisable because a 10% loss of plants is not uncommon under rain-fed field conditions and the planting density at harvest should be at least 60,000 plants/ha to achieve high yield. Planting more than 75,000 seeds/ha will not increase yield unless growing conditions are very favorable with a yield potential of >13 mt/ha. In drought-prone environments, planting density should not be more than 75,000 plants/ha.

The distance between rows should be narrow and just wide enough to allow field operations while plant spacing within the row should be wide to minimize plant competition for light, water, and nutrients. The optimal combination of row and within-row spacing should create a favorable microclimate in the canopy reducing the risk for pests and diseases. Fig. 3 shows the relationship between row and within-row spacing for different planting densities.

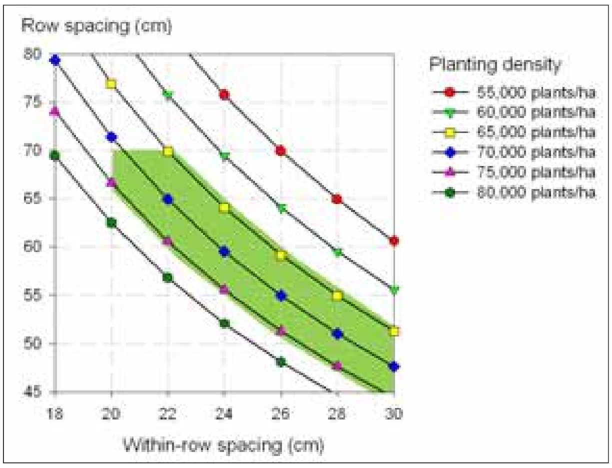

Fig. 3. Row and within-row spacing for different planting densities. The green area highlights the recommended combinations of row spacing and within-row spacing resulting in optimal planting densities for tropical maize. IPNI-IPI Southeast Asia Program. Unpublished.

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V Improving the productivity and profitability of maize in Southeast Asia

By Dr. C. Witt and J.M.C.A. Pasuquin, IPNI-IPI Southeast Asia Program, Singapore.

In 2004, the Southeast Asia Program of IPNI and IPI launched a new maize project on site-specific nutrient management (SSNM) for maize in Southeast Asia. The key objective was to assess opportunities and provide maize farmers with management options for increasing productivity and profitability. The identification of major production constraints in key maize growing areas and the development of tools to overcome those constraints using scientific principles and site-specific approaches are the main focus of this project. Improved crop and nutrient management strategies have been developed, evaluated, and refined and their delivery facilitated in partnership with national agricultural research and extension systems in the region.

Development and evaluation of SSNM in 2004-2007

The principles of SSNM for maize were developed through a series of researcher managed on-farm and on-station experiments covering a wide range of bio-physical and socio-economic conditions. On-farm trials were conducted for at least two seasons to estimate yield responses to the application of fertilizer N, P, and K and associated agronomic efficiencies (AE, kg grain per kg fertilizer nutrient applied). Additional on-station experiments were conducted by researchers of the Cereals Research Institute in Maros, Indonesia, to develop real-time N management strategies using a 4-panel leaf color chart (LCC) that was originally developed for rice (Witt *et al.,* 2004; Witt *et al*., 2005) and to investigate the interaction of planting densities and N management. The principles of SSNM were frequently updated as more experimental data became available and used to develop site-specific fertilizer recommendations for evaluation at project sites.

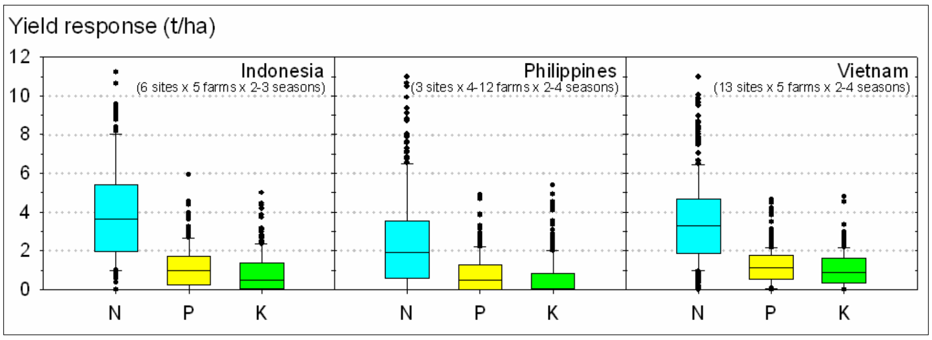

Fig. 1. Yield responses to the application of fertilizer N, P, and K. Note that 50% of all cases are within the box, 80% of all cases are within the whiskers, and bullets are outliers.

In the first year, a total of 120 on-farm experiments were set up in farmers' fields at 19 key maize growing sites in Indonesia, the Philippines, and Vietnam. Experimental treatments established in the on-farm trials included nutrient omission plots (-N, -P, and -K) to estimate nutrient-limited yield, a fully-fertilized treatment with ample application of fertilizer N, P and K to estimate attainable yield, and a farmer's fertilizer practice (FFP) to obtain the actual yield in farmers fields' as benchmark for comparison. Improved crop management (iCM) treatments were established at all sites but varied from site to site, depending on expected constraints to improving yield in farmers' fields. These treatments included manure application, lime application, or increased planting density (iPD). Varieties grown always included farmer-selected hybrids and, in some cases, open-pollinated varieties (OPV).

Fig. 1 provides an overview of yield responses to fertilizer application across sites in Indonesia, the Philippines, and Vietnam. In general, yield responses followed the order N >> P > K. In 75% of the cases, average yield responses to fertilizer N were <6 mt/ha in Indonesia, <4 mt/ha in the Philippines, and <5 mt/ha in Vietnam. Yield responses for fertilizer P and K were commonly in the range of 1 mt/ha. The measured yield responses to fertilizer application were used to calculate the site-specific fertilizer N, P, and K requirements to achieve optimal yields. Fertilizer P and K rates were further adjusted to avoid soil nutrient depletion.

As shown in Fig. 2, SSNM improved yield by about 1 mt/ha compared with the farmers' fertilizer practice (FFP) in each country and across all sites, but the full yield advantage with SSNM could often only be achieved once other

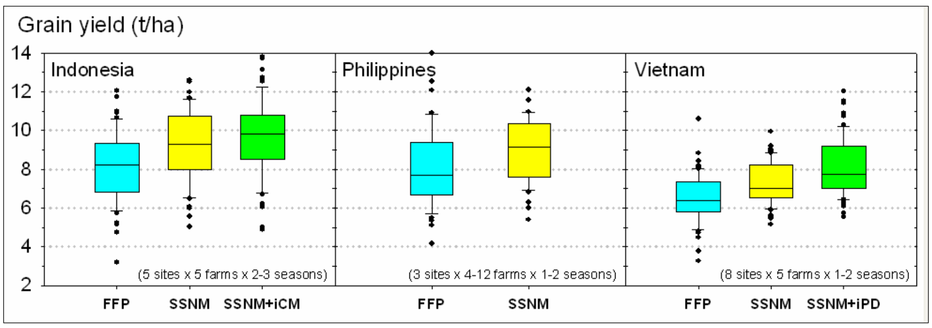

Fig. 2. Yield with farmers' fertilizer practice (FFP), SSNM, and SSNM in combination with other site-specific improvements (e.g. improved crop management, iCM, or increased planting density, iPD).

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constraints to yield improvement were addressed (SSNM+iCM and SSNM+iPD). One such constraint in Indonesia and Vietnam was low planting density.

The agronomic and economic performance of SSNM was evaluated in detail at all project sites as shown in the example for Indonesia in Table 1. In 2005/06 and across all sites except for drought prone sites in South Sulawesi, attainable yields ranged from 7 to 11 mt/ha with ample NPK supply, available hybrid cultivars, and current farmers' management practices (data not shown). Yield responses followed the order N >> P ≥ K with yield responses of 3 to 5 mt/ha to fertilizer N, 1 to 1.5 mt/ha to fertilizer P, and 0.5 to 1.5 mt/ha to fertilizer K application. Table 1 shows that significantly greater yield (+17%) and net benefit (+19%) were achieved with SSNM compared to farmers' practice despite larger investments in seeds (+10%) and fertilizer (+6%). Note that fertilizer P and particularly K was increased with SSNM at the expense of fertilizer N. Adjustments in fertilizer N, P, and K rates and better timing of fertilizer N applications were the key to achieving greater yield with SSNM.

Table 1. Agronomic and economic evaluation of the first SSNM crop in comparison to the farmers' practice (FP) across project sites in Indonesia (except Sulawesi) in 2005/06.

Parameters	Treatments		Relative change (%)
	FP	SSNM	
Yield (mt/ha)	7.4	8.7	+17
Fertilizer N (kg/ha)	212	165	-22
Fertilizer P_2O_5 (kg/ha)	72	81	+13
Fertilizer K_2O (kg/ha)	53	101	+92
Gross benefit (IDR/ha)	8,188,742	9,553,960	+17
N fertilizer cost (IDR/ha)	592,508	461,186	-22
P fertilizer cost (IDR/ha)	311,720	351,079	+13
K fertilizer cost (IDR/ha)	174,528	335,753	+92
Total fertilizer cost (IDR/ha)	1,078,756	1,148,018	+6
Plant density (seed/ha)	60,000	66,000	+10
Total seed cost (IDR/ha)	540,000	594,000	+10
Total cost (IDR/ha)	1,618,756	1,742,018	+8
Net benefit* (IDR/ha)	6,569,986	7,811,942	+19

Participatory evaluation in 2007/08

In 2007, the regional initiative on the development of Site-Specific Nutrient Management (SSNM) for Maize by the IPNI Southeast Asia Program and its partners entered a new phase. With sufficient evidence and promising results collected from researcher managed on-farm trials, SSNM has proven a reliable technology ready for wider-scale, participatory evaluation in partnership with farmers at project sites in Indonesia, the Philippines, and Vietnam.

Baseline agronomic surveys were conducted at project sites with significant opportunities for increasing productivity to obtain crucial information on current farmers' practices and serve as a reference for future impact analysis. Participatory evaluation of local SSNM guidelines commenced with farmer groups at project sites. Before the start of the season, farmers and researchers share their experiences, discuss management options, and agree on practices for participatory evaluation. Frequent meetings are held throughout the season in farmers' fields to refine SSNM through a dialogue between researchers and farmers. The final guidelines are discussed and approved by farmers and researchers for wider scale dissemination. Farmer participatory evaluation is an important step towards wider scale delivery of more knowledge intensive technologies like SSNM for maize in the research-extension continuum of IPNI-IPI and its partners in Southeast Asia.

Planning for wider scale dissemination of SSNM in 2008-2010 has begun involving existing collaborators and new stakeholders.

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Philippines: Dr. R. Labios (UPLB), Dr. A. Ocampo (IPB), Mrs. J. Labios (UPLB), Mr. H.C. Gines (PhilRice), Mr. C. Lapoot (NOMIARC), Mr. S. Tumamang (CVIARC).

Vietnam: Dr. P.S. Tan (CLRRI), Dr. T.T. Son (NISF), Dr. D.T. Binh (IAS), Dr. Nguyen My Hoa and Dr. Ngo Ngoc Hung (Cantho University), Dr. Ton Nu Tuan Nam (WASI).

We are very grateful to Dr. Achim Dobermann for his advice and guidance in the development and implementation of this project. Dr. Roland Buresh provided valuable comments on the development of SSNM for maize which is gratefully acknowledged.

The following institutes and organizations are collaborating partners and stakeholders in the project on *Site-Specific Nutrient Management for Maize in Southeast Asia.*

Indonesia:

- Indonesian Agency for Agricultural Research & Development (IAARD)
- Indonesian Center for Food Crops Research and Development (ICFORD)
- Indonesian Center for Soil & Agro-climate Research and Development (ICSARD)
- Indonesian Center for Agriculture Technology Assessment and Development (ICATAD)
- Indonesian Cereals Research Institute (ICRI)
- Indonesian Soil Research Institute (ISRI)
- Indonesian Agro-climate and Hydrology Research Institute (IAHRI)
- Assessment Institutes for Agricultural Technology (AIAT) East Java, North Sumatra, Central Java, Lampung, South Sulawesi

The Philippines:

- University of the Philippines Los Baños (UPLB)
- Bureau of Agricultural Research (BAR)
- Philippine Rice Research Institute (PhilRice)
- Department of Agriculture (DA) in Cagayan Valley Integrated Agricultural Research Center (DA-CVIARC) and in Northern Mindanao Integrated Agricultural Research Center (NOMIARC)

Vietnam:

- Vietnamese Academy for Agricultural Sciences (VAAS)
- Soils and Fertilizer Research Institute (SFRI)
- Western Highlands Agro-Forestry Scientific & Technical Institute (WASI)
- Institute of Agricultural Science of South Vietnam (IAS)
- University of Cantho
- Cuu Long Delta Rice Research Institute (CLRRI)

Linkages with Universities and International Organizations:

- University of Nebraska, Lincoln
- International Rice Research Institute (IRRI)
- International Maize and Wheat Improvement Center (CIMMYT)

The project on *Site-Specific Nutrient Management for Maize in Southeast Asia* is an initiative of the International Plant Nutrition Institute (IPNI) Southeast Asia Program, a join mission with the International Potash Institute (IPI).

2007 International Soil Science Award

Dr. Roland Buresh, Senior Soil Scientist at IRRI, was awarded the 2007 International Soil Science Award by the Soil Science Society of America at its annual meeting in New Orleans, Louisiana, USA. This prestigious award is given annually in recognition of outstanding achievement and service in the areas of international agricultural research, teaching, and extension.

For Dr. Buresh, this achievement included his leadership in formulating and disseminating improved practices of site-specific nutrient management (SSNM) in rice through partnerships with national research and extension organizations and the private sector in Bangladesh, China, India, Indonesia, Myanmar, the Philippines, and Vietnam. Starting in 2006, SSNM principles have been incorporated into national extension initiatives in Indonesia and Vietnam.

Before his return to IRRI in 2000, his work at the World Agroforestry Centre (ICRAF) in Kenya was instrumental in developing a 'science-based' understanding of soil and nutrient management in tropical agroforestry, which helped to heighten awareness of soil fertility depletion in Africa and to provide realistic assessment of the potential of agroforestry in soil fertility management. Throughout his career, his dedication to training and mentoring students and young scientists has had an expanding influence on soil science research throughout rice-growing Asia and eastern and southern Africa.

Source: IRRI Bulletin, 12-16 November 2007.

Dr. R. Buresh delivers a speech at the 2nd International Rice Congress, New Delhi, India, 2006. Photo by H. Magen.

Events

In December 2007:

"Potassium and Magnesium: Advances in Research and Application", IPI-IFS-Sabanci University joint symposium, 5-7 December 2007, Cambridge, UK.

The symposium was attended by more than 100 delegates. A more detailed report will be made in the next edition of *e-ifc,* March 2008. In 2008, eight selected papers of the symposium will be published in a special edition of Physiologia Plantarum.

Prof. Zed Rengel, University of Western Australia delivers his paper titled "Crops and Genotypes Differ in Efficiency of Potassium Uptake and Use".

Prof. Graham McGregor, University of London, delivers his paper titled "Beneficial Effects of Potassium on Human Health".

Coming Events

In March 2008:

IPI-BRRI-BFA International workshop on "Balanced Fertilization for Increasing and Sustaining Crop Productivity", 30 March-1 April 2008, Dhaka, Bangladesh.

The workshop is being jointly organized by IPI, Bangaladesh Rice Research Institute (BRRI) and Bangladesh Fertilizer Association (BFA).

A major new challenge in future food production is to meet the demand of the growing Asian population. Malnutrition remains endemic in Bangladesh, an overwhelmingly agrarian country and, without adequate measures, the level of vulnerability is likely to increase as a result of severe land degradation, soil erosion and the lack of appropriate technologies in agriculture. Successful diversification in crop production, which is helpful in providing ability to withstand market variability, requires wide dissemination of modern technologies for the cultivation of high value crops like fruits and vegetables. Research-based balanced application of mineral fertilizers will increase agricultural productivity for self-sufficient crop production and for maintaining soil fertility for future generations.

This workshop will provide an opportunity for delegates to discuss soil fertility issues and concerns resulting from the current status of fertilizer application, and to share experiences gained from advanced nutrient management practices.

For the full program look at the web or contact Dr. Vladimir Nosov (Vladimir.nosov@ipipotash.org).

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In December 2008:

Second International Symposium on Papaya 9-12 December 2008, Madurai, Tamil Nadu, India.

This symposium is being jointly organized by the International Society for Horticultural Science (ISHS), Leuven, Belgium in collaboration with Tamil Nadu Agricultural University, Coimbatore, India and other scientific organizations. The theme of the symposium is "Papaya for nutritional security". For further details, please contact the organizing secretary, Dr. N. Kumar, Professor (Horticulture), Tamil Nadu Agricultural University, Coimbatore 641 003, India. E-mail: kumarhort@yahoo.com, Phone: +91 422-6611310/6611377, (R): +91 422-2436046; Fax: +91 422-6611399, Mobile: +91 936 312 1916. Web: www.ishs-papaya2008.com.

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International Year of the Potato 2008

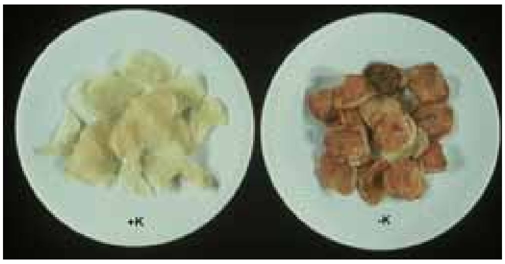
The United Nations General Assembly has declared 2008 as the International Year of the Potato (IYP) and FAO is leading its implementation. The IYP website has now been launched, providing a wealth of information about the IYP and its related events, as well as about the potato, including a series of fact sheets compiled by FAO specialists on key issues in potato development. One of the fact sheets is dedicated to the potato and biotechnology. See http://www.potato2008.org/en/potato/factsheets.html

Source:

http://km.fao.org/fsn/news_events0/fsn_detail.html?tx_ttnews%5Btt_news%5D=946&tx_ttnews%5BbackPid%5D=364&cHash=c191614a97

IPI is preparing a new web K center on P&P (Potato and Potassium) to be implemented during the first quarter of 2008.

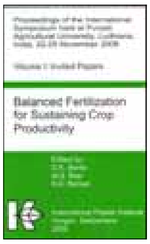
Coming Events



Effect of potassium on quality of potato chips. Photo by IPI.

For more events go to
http://www.ipipotash.org/conferences.php

New publications



Balanced Fertilization for Sustaining Crop Productivity, proceedings of the IPI-PAU International Symposium, Punjab Agricultural University, Ludhiana, India, 22-25 November 2006. Volume I: Invited papers, 559 p., Volume II: Extended abstracts of poster sessions, 30 p. Edited by Benbi, D.K., Brar, M.S., and S.K. Bansal. ISBN 978-3-9523243-2-5. International Potash Institute, Horgen, Switzerland.

The international symposium was jointly organized by the International Potash Institute (IPI) and the Punjab Agriculture University (PAU) with co-sponsorship by the India Council of Agricultural Research (ICAR), Fertilizer Association of India (FAI), Bangladesh Fertilizer Association (BFA) and the National Fertilizer Secretariat of Sri Lanka (NFS). The proceedings contain 32 papers from Bangladesh, Canada, China, Germany, India, Israel, Pakistan, Sri Lanka, Turkey, US and more, and present the state of the art on balanced fertilization in field crops, vegetables, fruit crops and plantations with relation to soil, crop and sustainability of the production system. Volume II of the proceedings contains the extended summaries of a total of 196 papers presented as posters during the symposium. The papers were grouped into the following 13 sections: Potassium in soils and fertilizers, Modern balanced fertilization techniques, Nutrient management in long-term fertilizer experiments, Nutrient management in diverse cropping systems, Nutrient management in cereals, in oil seeds and pulses, in fibre crops, in plantation crops, in sugarcane, in fruits, in vegetable flower and medicinal crops, in forage crops and tobacco, and finally the outreach activities. To order a copy, please contact Dr. S.K. Bansal, Director, PRII surinkumar@yahoo.co.in or Dr. M.S. Brar, Senior Soil Chemist, PAU, Email: brarms@yahoo.co.in & brarms@refiffmail.com
IPI website: http://www.ipipotash.org/publications/detail.php?i=238

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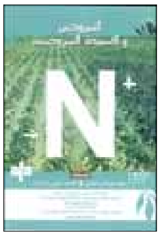

Nitrogen Facts in Brief. A new leaflet in Arabic by M. Rusan, Jordan University of Science and Technology, Irbid. 23 p., 2007.

The booklet describes the basic features of nitrogen fertilization and fertilizers. It is intended for use by farmers, extension officers and fertilizer dealers in the Arab region. The booklet is printed jointly with the Arab Fertilizer Association (AFA), Cairo, Egypt. Copies available at IPI Head Office and at AFA, Cairo, Egypt. For copies contact AFA (info@afa.com.eg) or IPI Coordinator WANA region Mr. M. Marchand (michel.marchand@tessenderlo.com)
IPI website: http://www.ipipotash.org/publications/detail.php?i=237

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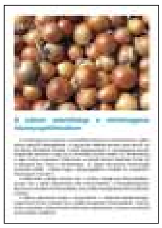

The importance of potassium for nutrient supply of onion (A kálium jelentősége a vöröshagyma tápanyagellátásában, in Hungarian), 8p., 2007. By A. Barnóczki, Onion Research Institute in Makó and Z. Némethy, Corvinus University, Budapest. For copies contact Dr. T. Popp, IPI Coordinator Central Europe at Thomas.Popp@kali-gmbh.com or download at http://www.ipipotash.org/publications/detail.php?i=235

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Coconut: For better yield: Chemical fertilizer. A poster in English and Sinhala. Dr. V. Nosov, IPI Coordinator east India, Bangladesh and Sri Lanka. 2007. This poster summarizes three years of demonstrations to farmers of the benefits of potash application in coconut trees. The posters can be downloaded at

http://www.ipipotash.org/publications/detail.php?i=224 (English) and

http://www.ipipotash.org/publications/detail.php?i=225 (Sinhala).

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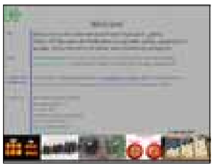
New publications



An update of ‘K Gallery’. 10-2007. The ‘K Gallery’ is a 52 slide show presenting the effects of potash fertilization in maize, rice, wheat, soybean, sugarcane, potato and many other crops. All photos are from IPI experiments in the fields, and it is constantly updated as fresh photos arrive. This presentation is for researchers, extension officer, dealers and of course farmers. *Have you got a good photo describing its effect on a specific crop? We will add it to this presentation with full acknowledgment.*

The presentation is available as PPS and PDF files with high and low resolution on the IPI website (http://www.ipipotash.org/k-center/detail.php?i=11)

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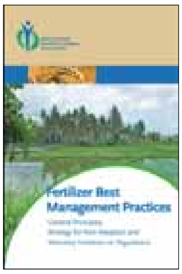

Proceedings of IFA workshop on “Fertilizer Best Management Practices—General Principles, Strategy for their Adoption and Voluntary Initiatives vs. Regulations”, 259 p., 2007, ISBN 2-9523139-2-X. Edited by Krauss, A., Isherwood, K., and P. Heffer. The papers in this proceedings were presented at the IFA International Workshop on Fertilizer Best Management Practices 7-9 March 2007, Brussels, Belgium. IFA decided in 2006 to launch an initiative on fertilizer best management practices (FBMPs). The proceedings include papers covering (i) the definition of the general principles of FBMPs and the strategy for their wider adoption; (ii) defining the role of the fertilizer industry in developing and promoting FBMPs and listing priority areas for action; (iii) exchanging information on experiences; (iv) reviewing achievements and identifying gaps; and (v) understanding the actors and identifying the key partners. In addition to the proceedings, all the papers and slides presented at the workshop are available in PDF format on IFA’s website at http://www.fertilizer.org/ifa/publicat/bap/2007_brussels_fbmp.asp

For hard copies please email: publications@fertilizer.org

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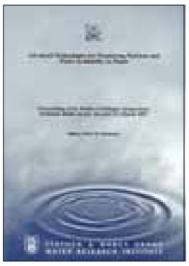

Proceedings of the Dahlia Greidinger symposium on "Advanced technologies for monitoring nutrient and water availability to plants", 166p., 2007. Edited by Neumann, P.M., Technion, Haifa, Israel. This volume presents eight chapters describing invited lectures given at the symposium and gives an idea of the diverse and interesting subject matter which was discussed. The first four chapters review new detection-technologies for laboratory and field monitoring of nutrient levels and other parameters, in plant and soil matrices. Chapter five introduces a novel approach to the integrative assessment of physical, biological, and chemical properties of soils, in order to facilitate better soil management. Chapters six, seven and eight review the application of spectral techniques for the remote assessment of vital crop and soil parameters in the field. Finally, chapter nine describes the development of a wireless valve network which will be capable of optimizing the controlled application of water, fertilizers, and agricultural chemicals through large-scale irrigation systems. The abstracts of other talks and contributed posters are also included.

For copies please contact Prof. emeritus Joseph Hagin at haginj@tx.technion.ac.il

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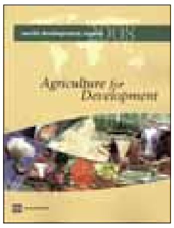

Agriculture for Development. World Development Report (WDR) 2008. 2007. Published by the World Bank, Washington, USA. 365p. ISBN 978-0-8213-6808-4.

The latest World Development Report calls for greater investment in agriculture in developing countries and warns that the sector must be placed at the center of the development agenda if the goals of halving extreme poverty and hunger by 2015 are to be realized. Titled ***“Agriculture for Development”,*** the report says the agricultural and rural sectors have suffered from neglect and underinvestment over the past 20 years. While 75 percent of the world’s poor live in rural areas, a mere 4 percent of official development assistance goes to agriculture in developing countries. In Sub-Saharan Africa, a region heavily reliant on agriculture for overall growth, public spending for farming is also only 4 percent of total government spending and the sector is still taxed at relatively high levels. The World Bank Group is advocating a new ‘agriculture for development’ agenda. According to the WDR, for the poorest people, GDP growth originating in agriculture is about four times more effective in reducing poverty than GDP growth originating outside the sector.

For more details see http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/EXTWDR2008/0,,contentMDK:21488982~pagePK:64167689~piPK:64167673~theSitePK:2795143,00.html

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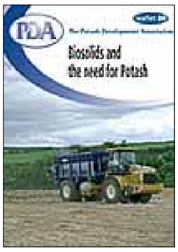
Publications by the PDA

New publications from the Potash Development Association, UK.

See also http://www.pda.org.uk/

Note: Hardcopies of PDA's publications are available only in the UK and Ireland.



Biosolids and the need for Potash. No. 20, update.

Biosolids (sewage sludge) provide valuable plant-available nutrients and have useful soil conditioning properties. They are subject to regulations which require that the application rates of specific heavy metals and their concentrations in soils are not exceeded, that disease risks to stock and humans are minimised and that applications should match the requirements of crops. Rates of applications are therefore important and so is the balance of nutrients. Water companies go beyond the regulations by agreement with stakeholders. Potential contaminants have been greatly reduced over the years by cooperation with industry, with their removal at source, and by legislation that has prevented the manufacture and sale of hazardous substances. Biosolids provide useful quantities of nitrogen and phosphate, but only modest amounts of potash and magnesium because these elements are quite soluble and are washed out in the treated water. Lime stabilised biosolids are a useful liming material.

http://www.pda.org.uk/leaflets/20/no20-p1.htm

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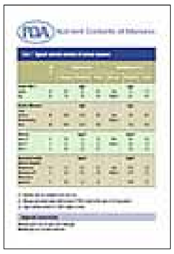

Nutrient contents of manures.

This leaflet presents a detailed table on N, P and K content in various sources of manures and slurries and a table with recommendations of various manures in different soil types and conditions. Available at http://www.pda.org.uk/others/npkcoam.html

K in the literature

Increasing applications of potassium fertiliser to barley crops grown on deficient sandy soils increased grain yields while decreasing some foliar diseases. Brennan, R.F., and K.W. Jayasena. 2007. Aust. J. of Agric. Res. 58:680–689.

www.publish.csiro.au/view/journals/dsp_journal_crossref_cites.cfm?nid=84&f=SR9680105

Abstract:

Most sandy soils used for cropping in south-western Australia (SWA) have now become potassium (K) deficient due to removal of K in hay and grain, so it is now profitable to apply K fertiliser to most barley (*Hordeum vulgare* L.) crops in the region. Leaf diseases of barley crops in the region have increased in recent years particularly in the in medium to high (350–600 mm annual average rainfall) areas of SWA. Seventeen field experiments were undertaken to determine the effect of applications of K fertiliser, either the chloride (KCl) or sulfate source (K_2SO_4), on grain yield increases and on the percentage leaf area diseased (%LAD) when diseases were controlled or not controlled by fungicide sprays. Maximum grain yield of barley was achieved where adequate K fertiliser (~8–22 kg K/ha) was applied and leaf diseases were controlled by fungicide. Applying increasing amounts of applied K fertiliser (0–120 kg K/ha) to barley decreased the %LAD by powdery mildew (*Blumeria graminis* f. sp. *hordei Syn.*) and spot-type net blotch (*Pyrenophora teres* f. *maculate* (Sacc.) Shoem.) and increased grain yield. By contrast, when leaf rust (*Puccinia hordei* G. Otth) was present the %LAD was unaffected by K application. When powdery mildew was the major disease, larger increases in grain yields and larger reductions in %LAD were obtained when KCl was used instead of K_2SO_4. About twice as much K fertiliser as K_2SO_4 was required for 90% maximum grain yield compared with KCl where powdery mildew was present. Applying larger amounts (>40 kg K/ha) of K fertiliser than required to achieve maximum grain yields did not further reduce %LAD by powdery mildew. There were no significant differences between the 2 sources of K fertiliser on the %LAD by spot-type net blotch. Generally, the percentage protein content and hectolitre weight of grain were unaffected by K fertiliser. Potassium fertiliser decreased the percentage grain <2.5mm (known locally as screenings) and control of the foliar leaf diseases by applications of fungicide resulted in a decrease in protein content and screenings and increased hectolitre weight of barley grain. The concentration of K in dried shoots that was related to 90% of the maximum shoot yield (critical diagnostic K) decreased as the plant matured, and was ~41 g/kg at Z22, ~30 g/kg at Z32, ~20 g/kg at Z40, and ~15 g/kg at Z59. The concentration of K in dried shoots which was related to 90% of the grain yield (critical prognostic K) decreased as plant matured, and was similar to critical diagnostic K values. Leaf disease had little effect on critical concentrations of K at early growth stages (Z22 and Z32).

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K in the literature

Performance of Site-Specific Nutrient Management for Irrigated, Transplanted Rice in Northwest India. Khurana, H.S., Phillips, S.B., Bijay-Singh, Dobermann, A., Sidhu, A.S., and S. Peng. 2007. Agron. J. 99:1436–1447.

http://agron.scijournals.org/cgi/content/abstract/agrojnl;99/6/1436

Abstract:

Like in other parts of Asia, irrigated, transplanted rice (*Oryza sativa* L.) yield increases in Punjab, India, have slowed down in recent years. Further yield increases are likely to occur in smaller increments through fine-tuning of crop management mainly by accounting for the large spatial and temporal variation in soil characteristics. On-farm experiments were conducted from 2002 to 2004 at 56 sites in six key irrigated rice-wheat (*Triticum aestivum* L.) domains of Punjab to evaluate an approach for site-specific nutrient management (SSNM). Field-specific NPK applications were calculated by accounting for the indigenous nutrient supply, yield targets, and nutrient demand as a function of the interactions between N, P, and K. The performance of SSNM was tested for two rice crops. Compared with the current farmers' fertilizer practice (FFP), average grain yield increased from 5.1 to 6.0 Mg/ha, while plant N, P, and K accumulations increased by 13 to 15%. The gross return above fertilizer cost (GRF) was about 14% greater with SSNM than with FFP. Improved timing and/or splitting of fertilizer N increased N recovery efficiency from 0.20 kg/kg in FFP plots to 0.30 kg/kg in SSNM plots. The agronomic N use efficiency was 83% greater with SSNM than with FFP. The year-wise effect on all parameters was, however, nonsignificant. As defined in our study, SSNM has potential for improving yields and nutrient efficiency in irrigated, transplanted rice.

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Categorisation of soils based on potassium reserves and production systems: implications in K management. Srinivasarao, Ch., Vittal, K.P.R., Tiwari, K.N., Gajbhiye, P.N., and S. Kundu. 2007. Aust. J. of Soil Res. 45:438-447.

http://www.publish.csiro.au/?paper=SR07024

Abstract:

Crop fertilisation with potassium in rainfed agriculture in India is not practised, merely on the assumption that Indian soils are rich in potassium and crops do not need external K supply. However, under continuous cropping in rainfed regions, huge crop K removals are reported, up to 150–200 kg/ha annually, depending upon amount and distribution of rainfall and biomass production. Thus, most of the crops essentially deplete soil K reserves. The present study evaluates the soil K reserves under diverse rainfed production systems and categorises rainfed soils based on different soil K fractions. Depth-wise sampling was done from 21 locations across different soil types under eight production systems, and various fractions of soil K were determined. Total K was highest in Inceptisols (1.60–2.28%), followed by Aridisols (1.45–1.84%), Vertisols and Vertic sub-groups (0.24–1.72%), and Alfisols and Oxisols (0.30–1.86%), showing a wide variation within each group. Nonexchangeable K reserves were found in a proportionate manner to total K in most of the soil profile. Unlike nonexchangeable K reserves, Vertisols had higher exchangeable K than Inceptisols and Alfisols/Oxisols. Nonexchageable K showed significant positive correlation with total K in Inceptisols and Vertisols, whereas it was non-significant in Alfisols/Oxisosls. However, significant positive correlations were recorded with exchangeable K and nonexchangeable K in all soil types, indicating the dynamic equilibrium between 2 soil K fractions.

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Effect of CO_2 Enrichment on the Growth and Nutrient Uptake of Tomato Seedlings. Li, J., Zhou, J., Duan, Z.Q., Du, C.W., and H.Y. Wang. 2007. Pedosphere 17(3):343-351.

Abstract:

Exposing tomato seedlings to elevated CO_2 concentrations may have potentially profound impacts on the tomato yield and quality. A growth chamber experiment was designed to estimate how different nutrient concentrations influenced the effect of elevated $C0_2$ on the growth and nutrient uptake of tomato seedlings. Tomato (Hezuo 906) was grown in pots placed in controlled growth chambers and was subjected to ambient or elevated CO_2 (360 or 720 L L^{-1}) and four nutrient solutions of different strengths (1/2-, 1/4-, 1/8-, and 1/16-strength Japan Yamazaki nutrient solutions) in a completely randomized design. The results indicated that some agricultural characteristics of the tomato seedlings such as the plant height, stem thickness, total dry and fresh weights of the leaves, stems and roots, the *G* value (*G* value = total plant dry weight/seedling age), and the seedling vigor index (seedling vigor index = stem thickness/(plant height x total plant dry weight) increased with the elevated CO_2, and the increases were strongly dependent on the nutrient solution concentrations, being greater with higher nutrient solution concentrations. The elevated CO_2 did not alter the ratio of root to shoot. The total N, P, K, and C absorbed from all the solutions except P in the 1/8- and 1/16-strength nutrient solutions increased in the elevated CO_2 treatment. These results demonstrate that the nutrient demands of the tomato seedlings increased at elevated CO_2 concentrations.

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K in the literature

Nutrient Balance in Rice. Panda, D., Samantaray, R.N., Misra, A.K., and H.K. Senapati. 2007. Indian J. of Fertilzers 3(2): 33-38.

Abstract:

Study of nutrient balance in rice helps in optimization of fertiliser application for achieving higher rice productivity and improving soil quality. Imbalanced use of fertilisers has deleterious effect on soil fertility and rice yield in long run. Over a period of 21-23 years, the average response to 30-60 kg K_2O/ha in laterite soil at Bhubaneswar, red loam soil at Hyderabad and Terai soil at Pantnagar varied from 0.4-0.6 t/ha. The share of N in total grain yield response to NPK+FYM decreased and that of P and K increased with years of cropping at all locations. In general, with application of N as well as P, there was positive balance of these two nutrients in rice-rice system. But even with application of K fertilisers @ 40-60 kg K_2O/ha, the K balance in rice was negative suggesting the need for adequate supply of K to rice for obtaining sustainable high yield. The sustainable yield index was higher in the integrated use of N, P, K and farmyard manure than N, NP and NPK.

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Soil and Tissue Phosphorus, Potassium, Calcium, and Sulfur as Affected by Dairy Manure Application in a No-Till Corn, Wheat, and Soybean Rotation. Parsons, K.J., Zheljazkov, V.D., MacLeod, J., and C.D. Caldwell. 2007. Agron. J. 99(5):1306-1316.

http://agron.scijournals.org/cgi/content/abstract/99/5/1306

Abstract:

The hypothesis of this study was that surface applied liquid manure may provide sufficient nutrients to silage corn (*Zea mays* L.), wheat (*Triticum aestivum* L.), and soybean [*Glycine max* (L.) Merr.]under a no-till system in the cool wet climate of Atlantic Canada. A 2-yr field study was conducted investigating the effect of crop rotation and fertility on P, K, Ca, and S availability to corn silage, spring milling wheat, and soybean in Nova Scotia, Canada. The rotations consisted of all six possible combinations of corn, wheat, and soybean, and the fertility treatments consisted of three rates of liquid dairy manure (LDM1-3) at 32.1, 48.1, and 64.3 Mg/ha, a mineral fertilizer treatment, and a control (no fertility applied). In general, nutrient availability as measured by Mehlich 3 (M3) was not well correlated with tissue concentration. Tissue S in corn was lower when it was grown after soybean than when grown after wheat, and was highest in the LDM1 and in the control treatments. Rotation x fertility effects observed in the wheat nutrient removals were accountable to similar differences in yield. Wheat uptake of P was significantly affected by fertility, with the highest removal of P occurring in the NPK treatment, which also provided the highest yield. Results indicate that Ca uptake by wheat may be hindered by competition with K, and that K applied in manure at higher rates could build up over time. Potassium recovery in wheat was higher from the inorganic NPK treatment (37%) than from manure (from 16 to 4%). There were few differences in M3 available nutrients in 2001. However in 2002, LDM application resulted in higher M3 concentrations of K and Ca; there was a drop in P availability with the LDM3 (at 64.3 Mg/ha) application; and S availability was highest at LDM1 and LDM3 (32.1 and 64.3 Mg/ha, respectively). Further long-term studies may be needed to determine if surface applied LDM with no incorporation can sustain silage corn, soybean, and wheat nutrient requirements for P, Ca, K, and S, and maintain efficient nutrient use overtime under no-till conditions.

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The Long-Term Impact of Phosphorus and Potassium Fertilization on Alfalfa Yield and Yield Components. Berg, W.K., Cunningham, S.M., Brouder, S.M., Joern, B.C., Johnson, K.D., Santini, J.B., and J.J. Volenec. 2007. Crop Science, 47(5):2198-2209.

http://crop.scijournals.org/cgi/content/abstract/cropsci;47/5/2198

Abstract:

Addition of P and K fertilizer can increase alfalfa (*Medicago sativa* L.) yield and stand persistence, but the yield components associated with P- and K-induced variation in agronomic performance are not clear. Our objectives were: (i) to determine the impact of P and K nutrition on productivity of a relatively old alfalfa stand; and (ii) determine which yield components are associated with changes in alfalfa forage yield. Treatments were a factorial combination of four P and five K rates replicated four times. Forage harvests occurred four times annually. Plant populations were determined in early December and late May each year. When compared to unfertilized plots, addition of P and K increased forage yield each year. Fertilization with P decreased plants m^2 at all K application rates, but especially in plots fertilized with P, but not K. By comparison, plots fertilized with K, but not fertilized with P, had the higher plant population densities. Although regression analysis eventually revealed a positive association between forage yield and shoots m^2 in 2003 and 2004, the greatest forage yields were not obtained in plots with the greatest plant population densities, shoots/plant or shoots/m^2. Regression and path analysis revealed that improved forage yield in P and K fertilized plots was consistently associated with greater mass/shoot.

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K in the literature

Influence of Nitrogen and Potassium Supply on Contents of Acrylamide Precursors in Potato Tubers and on Acrylamide Accumulation in French Fries. Gerendás, J., Heuser, F., and B. Sattelmacher. 2007. J. of Plant Nutr. 30(9):1499-1516.

http://www.informaworld.com/10.1080/01904160701555846

Abstract:

Fried potato products may accumulate substantial amounts of acrylamide due to high precursor contents, namely reducing sugars and asparagine. In a two-factorial experiment increasing N supply, increased the contents of reducing sugars in most cases, and resulted in higher contents of free amino acids. α-amino-N, which was tightly correlated with the contents of free amino acids, can be regarded a suitable rapid test for free asparagines for a given variety. Increasing K addition always raised the citrate contents, but lessened the contents of reducing sugars. Selected treatments were processed into French fries. Highest acrylamide contents were observed in tubers grown with high N and inadequate K supply, which also contained the highest contents of precursors. The experiment clearly demonstrates that nutrient supply has significant impact on the contents of acrylamide precursors and thus for the acrylamide formation during frying.

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Read on:

- **Feeding a Hungry World**

  This editorial from Norman Borlaug who was awarded the Nobel Peace Prize in 1970 was published in Science magazine, 19 October 2007. It starts…"Next week, more than 200 science journals throughout the world will simultaneously publish papers on global poverty and human development - a collaborative effort to increase awareness, interest, and research about these important issues of our time." In this editorial, Dr. Borlaug describes the challenges the world is facing and the role of advanced agriculture in meeting these challenges.

  http://www.sciencemag.org/cgi/content/full/318/5849/359

- **The Impact of Agricultural Soil Erosion on the Global Carbon Cycle**. Van Oost, K., Quine, T.A., Govers, G., De Gryze, S., Six, J., Harden, J.W., Ritchie, J.C., McCarty, G.W., Heckrath, G., Kosmas, C., Giraldez, J.V., Marques, J.R., and R. Merckx. Published in Science, Vol. 318 Issue 5850, pp 626-629.

- **Assessing the Impact of the National Agricultural Advisory Services (NAADS) in the Uganda Rural Livelihoods.** Benin, S., E. Nkonya, G. Okecho, J. Pender, S. Nahdi, S. Mugarura, E. Kato, and G. Kayobyo. October 2007. IFPRI Discussion Paper 724.

  http://www.ifpri.org/pubs/dp/ifpridp00724.asp

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K for thought

Farmers around the world: Avocado grower in Israel wins the "Excellent Farmer 2006 Award"

By H. Magen.

Mr. Zvi Harat (Ziki to his friends, including myself who has worked closely with him in the past), aged 68 is an avocado grower from Kibbutz Givat Brenner, situated about 45 minutes drive south of Tel Aviv, Israel. Ziki has been working in the Kibbutz avocado orchard since it was first planted in 1978. Our story is about Ziki, the avocado orchard he planted 30 years ago, and recognition of his contribution to the avocado industry in Israel.

In early 2007, Carmel Agrexco - the largest exporter of agricultural produce in Israel - presented Ziki with the "Excellent Farmer for 2006" in the export fruit sector. The award states that Ziki "is one of the pillars of the avocado sector in Israel", and that his achievements are reflected by the high productivity of the orchard and ratio of exported fruit. Ziki was also praised for "working in close collaboration with research and extension, and his team for taking an active part in the stewardship of young agronomy students" at various research forums.

As far as is known, the first avocado (*Persea Americana* Mill) trees were brought to Israel in 1908 to the French Monastery in Latrun, near Jerusalem (Shachar, 1982). Until the early fifties, avocado trees planted commercially did not exceed 2,000 and were grown mostly in the central coastal plain. Since the end of the fifties, many commercial orchards have been planted in most parts of Israel, for thought

and - by 1975 - the total area had increased to 3,600 hectares. Since 1990, the avocado area in the country declined from almost 9,000 to 5,100 ha in 2005, yet productivity tripled from 566 to 1679 kg/ha (FAOSTAT, November 2007). Many rootstocks are now used, depending on the soil and climatic conditions. For example, West Indian rootstocks have been developed for planting/growing in heavy lime soil or where irrigation water has a high salt content.

The Kibbutz Givat Brenner avocado plantation is planted over 32 hectares, on relatively heavy soil (~50% clay) with pH=7.5. Planting during recent years has been in high beds (up to 80 cm) and the whole orchard is now drip irrigated with three laterals per row, an emitter every 30 cm, and a discharge rate of 1.8 l/h each. The main cultivars are Hass, Etinger, Fuerte and Reed. Irrigation water used is mostly treated wastewater (TWW) to a secondary-tertiary level, with levels of Cl ranging from 100 ppm at the beginning of the irrigation season (April) to 250 ppm Cl at the end of the irrigation season (November).

Mr. Shalom Simhon, Minister of Agriculture, Israel (left) with Mr. Ziki Harat (right) at the award ceremony.

During the last 25 years, Ziki has regularly sampled leaves from sub-plots and by cultivar, from which a detailed fertilization program is prepared. All fertilization is done via fertigation, which is fully controlled by a PC situated in the orchard and at Ziki's home, 15 kilometres away. Application rate of nutrients is 300, 60 and 400-650

Haas avocado, Western Galilee, Israel. Photo by A. Lowengart-Aycicegi.

kg of N, P_2O_5 and K_2O respectively, per hectare. During the last few years, Ziki has started applying SOP in winter to deliver some of the high potassium levels required, and used phosphoric acid as the P source, applied towards the end of the summer. This has the added benefit of also cleaning the drip system. Source of N is ammonium nitrate and ammonium sulphate solutions, with reduced Cl levels of potassium fertilizers. Constant iron deficiency requires the application of 10 litres/ha of dissolved sequestrin (FeEDDHA).

I asked Ziki how he is able to pay for all these expensive inputs. "Well," he said," you should ask first about the cost of water." I did. Ziki pays between USD 0.2 to 0.4 per cubic metre (m^3), and uses about 10,000-12,000 m^3/ha. "This is our most expensive input, and we do whatever we can to make optimal use of the water we have," he explained. During the last four years, Ziki (and the kibbutz) have been significantly rewarded for the extensive investment in the orchard, and he harvests close to 20 mt/ha every year. He estimates the total inputs (including labor) at approx. USD 10,000/ha, and returns at approximately USD 13,000/ha.

Avocado research in Israel is carried out in close participation with farmers, and Ziki is a member of the R&D team at the Israeli Avocado Consortium. The consortium receives its funding from growers, and the government matches this contribution. Researchers at the Faculty of Agriculture (Hebrew University of Jerusalem), ARO Volcani Center and applied research centers, funded and run by farmers, compete for research grants. According to Ziki, the main challenges that avocado growers in Israel face today are improving the size of Hass, reduction in yield variations, biological pest control, and better use of treated wastewater.

I asked Ziki about the award he received and what it means to him and to the kibbutz where he has lived since he was born. "For me", he said, "the meaning of the award is the message it delivers of the need to assist the younger generation to see that there is a future in agriculture."

Thank you Ziki. We congratulate you on winning this prestigious award and we wish you many more fruitful years in the field.

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Shachar, Z. The Avocado in Israel. California Avocado Society. 1982. Yearbook 66:103-108. (www.avocadosource.com/CAS_Yearbooks/CAS_66_1982/CAS_1982_PG_103-108.pdf)

Avocado orchard on high beds, Western Galilee, Israel. Photo by A. Lowengart-Aycicegi.

Clip board

New IPI Coordinator for China

Dr. Patricia Imas, IPI Coordinator India, has assumed the additional responsibility and position of IPI Coordinator China, effective September 2007. Dr. Imas is especially familiar with the agricultural conditions in South Asia, and has over 10 years experience working with farmers, dealers, extension workers, researchers and state officials.

IPI activity in China started in the 80's, working alongside research institutes in the country. During the last decade, IPI has collaborated with a broad range of stakeholders, including research, extension, and soil and fertilizer institutes (SFI). IPI activity in China is focused on research projects in major crops and wide-scale dissemination and training programs.

By training, Dr. Imas is an Agronomic Engineer from the Faculty of Agronomy, University of Buenos Aires, Argentina. She completed her MSc and PhD at the Department of Soil and Water Sciences, Faculty of Agricultural, Food and Environmental Quality Sciences, The Hebrew University of Jerusalem, Israel. Her MSc thesis focused on the "Relationship between yield and transpiration under different nutrition", and her PhD thesis, supervised by Prof. U. Kafkafi, on "Chemical and biological processes in the rhizosphere affecting phosphorus mobility and uptake conditions".

Dr. Imas has comprehensive knowledge of the specific crops grown in Asia including rice, wheat, soybean, pulses, and medicinal plants. She has published papers in peer review journals and served as an editor for IPI proceedings.

In recent years, Dr. Imas, as IPI Coordinator for India and the Fertilizer Association of India (FAI), jointly developed and implemented regular training programs for dealers and farmers, involving over 1,500 people from across India. She has also produced numerous leaflets in various Indian languages, and presented her research projects at international events.

Dr. Imas is also the representative of Dead Sea Works Ltd. at the Technical Secretariat of IPI, and is in charge of developing improved media and communication tools for the institute.

We, at IPI, believe that Dr. Imas's rich experience in launching research and training programs, as well as her skills in communication, will significantly benefit the various research and extension projects IPI implements in China.

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