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CONTENTS

Message from the President 3
Increasing Phosphate Fertilizer Use for Achieving Worldwide Sustainable Agriculture 4
Phosphorus Compounds: Associated Environmental Issues and New Applications 11
Communication and Retrieval of Information 14
Phosphate Fertilizer Trends and Outlook 20
Activities of the Executive Arms and Advisory Bodies of IMPHOS 26
Abbreviations and Acronyms 28
About IMPHOS 29

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Front cover: Oil palm trees intercropped with legume, IMPHOS project in Malaysia
To help create synergies, the Institute developed partnerships with public institutions, e.g. national research agricultural systems, international agricultural research centers such as IRRI (International Rice Research Institute) and ICARDA (International Center for Agricultural Research in the Dry Areas), United Nations Agencies, namely the FAO (the Food and Agriculture Organization), the IAEA (The International Atomic Energy Agency) and UNEP (United Nations Environment Program), specialized committees such as SCOPE (the Scientific Committee on Problems of the Environment), universities and the private sector (fertilizer companies). IMPHOS has also much strengthened its collaboration with fertilizer industry associations that include IPI (International Potash Institute), AFA (Arab Fertilizer Association), IFA (International Fertilizer Industry Association), FAI (Fertilizer Association of India) and PPI (Phosphate and Potash Institute). In addition, it has closely cooperated with international institutions, such as The European Union, in order to more efficiently conduct promotional activities and improve food and nutrition security in several regions of the world. By doing so, it has contributed to enhance the image of the phosphate industry.

As most of the increase in food production will have to come in the future from use of agricultural inputs and improved technology; especially in developing regions where the gap is still very wide between actual and potential yields, and as food and nutrition security are still the main challenges to human welfare and economic growth in many developing countries, IMPHOS will endeavor to meet these challenges. To fulfill its pledge, the Institute is fostering responsible use of phosphate fertilizers, dealing adequately with emerging issues such as food quality and food safety and responding to the need for diversified food production including vegetables, fruits and animal-derived products. It is undertaking technical research into industrial applications of phosphates in order to develop environment friendly technologies.

The findings from IMPHOS various undertakings are being widely conveyed to farmers, end-users, decision-makers, as well as to the world scientific community using, on the one hand, its existing communication channels, i.e. the IMPHOS Phosphate Newsletter, the IMPHOS website, press releases and printed documents, and the organization of events such as conferences, seminars and workshops, and on the other hand, is searching for other relevant ways to widely communicate scientifically-based information on phosphates and its various uses.

In introducing this annual report that presents the reader with a full account of the institute's most recent undertakings and achievements, I am confident that the pursuit by IMPHOS of the goals stated in its mandate, will enable it to measure up to the challenging tasks ahead.

MOSTAFA TERRAB
LONG-TERM PROMOTIONAL ACTIVITIES ON BALANCED FERTILIZER USE IN PAKISTAN

Imbalance in fertilizer use has been a preoccupation of research and development agencies in Pakistan for many years. Fertilizer use began in 1952-53 with the introduction of nitrogen; phosphate was first imported into the country seven years later in 1959-60, and potassium same seven year later, in 1966-67.

The use of nitrogen (N) was about ten times more than that of phosphorus (P) in the seventies (1971-72), and N:P ratios reached a plateau of around four in the eighties, and fluctuated between 3.3 in 1987-88 to the extreme of 4.7 in 1996-97. After another decade, these ratios remained the same, still wide compared to the recommended standard of 2:1.

Pakistan soils are mainly deficient in nitrogen and phosphorus. The deficiencies of potassium and micronutrients are also being reported but not to the extent of nitrogen and phosphorus. Mineral fertilizers have played a significant role in overcoming the problems of nutrient deficiency but the main constraint in exploiting the full potential remains the imbalanced use of fertilizers, particularly the low amounts of phosphorus in relation to nitrogen. A balanced fertilization programme is the cornerstone for maximizing crop yields, increasing profits, improving the efficiency of applied fertilizers and conserving of the national resource base.

The stagnation in phosphate use at the farm level has created concern as it may affect overall agricultural productivity. The National Fertilizer Development Centre (NFDC), with the support of the World Phosphate Institute (IMPHOS), and the Food and Agriculture Organization (FAO), in collaboration with provincial organizations, has launched a project on “Balanced fertilization through phosphate promotion”. The main objective was to demonstrate the quantitative increase in yield through balanced use of phosphate fertilizers with nitrogen, investigate economic returns and persuade farming community regarding the need for adequate use of phosphate.

After three phases of activities (I: from 1987 to 1990, II: from 1996 to 2000, and III: from 2002 to 2006), the number of trials was more than 720 for demonstration purpose, and 190 for complementary studies; which related to:

- Methods of P application;
- P requirement of high-responsive crops;
- Residual effect of P.

Conclusions and recommendations

The findings in this eighteen-year project show that balanced use of nitrogen and phosphorus increases both productivity and profitability for farmers. The impact on crop production was, on average, 30% over the national production, if the balanced fertilization done on 50% of Crop Production Area (CPA), and gave a financial gain of 9,558 million Rs (159 million US $), pushing ahead the whole agriculture sector, securing against wheat shortage for a long period.

The results will lead also to a big change in fertilizer consumption, decreasing nitrogen use by 503 thousand tonnes, increasing phosphorus use by 209 thousand tonnes, and giving a beneficial balance sheet of 2,513 million Rs (42 million US $).

In order to achieve these objectives, specific actions should be taken at several levels: political, industrial, research, and development:

- removing the 15% tax on fertilizers, putting them on equal footing with wheat; in the same spirit, establishing
the price ratio of phosphate and nitrogen at the same level as the international market. As phosphate is a factor for high productivity and sustainability for soil fertility, it should be as important as nitrogen.

● Associating producers of fertilizers and users, to define the requirements of the agricultural sector, and the conditions of manufacturing compound formula adapted to different crops, ecological zones, farming systems, with appropriate balance of nutrients, coating of granules, to facilitate handling and application, to ensure effectiveness and minimise lost.

● Promoting balanced and integrated use of fertilizers, method and time of application, including organic sources to amend the soil and to increase the efficiency of mineral fertilizers; these activities should be stepped up with fertilizer producers to accelerate the adoption and feedback of information from the farmer.

The project has already yielded substantial and valuable results, in particular the demonstration trials that totaled 720 and the Special Programme with 515 tests. In addition, there were farmer’s field days organized in the 4 provinces, national symposia and documents and information made available to extension services: brochures and pocket guides translated into regional languages. The impact on the farmer’s seems to be important.

These results have been promoted through leaflets, workshops, TV, media and radio in Pakistan, and internationally at symposia and conferences organized in China, Singapore, and Egypt.

PHOSPHATE FERTILIZER MANAGEMENT IN OIL PALM PLANTATIONS IN MALAYSIA AND INDONESIA

MALAYSIA

Phosphorus is one of the major nutrients required for palm oil production. The major source used to supply this nutrient has been phosphate rock (PR), with Malaysia becoming a major user of PR for direct application to oil palm. In 2005, a total of 4.0 million ha of land was planted with oil palm and the average amount of PR used per palm was between 1-3 kg PR depending on the age of palm. To meet the demand, Malaysia became a major importer of PR.

Over the past 25 years, P fertilization has resulted in build-up of P stocks in the perennial cropping systems. A high residual effect in soil has been reported where recommended rates of PR have been applied over a crop cycle (20-25 years) such that responses in replanted oil palm to P fertilizers are often small.

While PRs have been found to be an effective source of P for oil palm, they differ in quality, solubility, and effectiveness, both in short- and long-term effects. For instance, the effects of direct application of Christmas Island PR on mature oil palm are well documented. However, the agronomic effectiveness of other PRs that are now available in the Malaysian fertilizer market on mature oil palm is scanty. Thus, it is relevant and important to study the agronomic effectiveness of low, medium, and highly reactive PRs for oil palm grown on different soil types (including the deep peat) and ecological regions in Malaysia.

In addition, organic materials have been shown to have positive effects on PR dissolution resulting in the improvement of the agronomic effectiveness of the PR. Leguminous cover crops have long been used during early planting of oil palms and are known to improve palm growth and yield. PRs have been applied to these legume covers during establishment and the initial 1-4 years of palm growth to maintain good ground cover. Little is known on the recycling of the PRs added to these legumes to oil palm after these covers die off due to shading by the oil palm tree. Furthermore, most plantations are now returning the oil palm wastes obtained from the mill, such as empty fruit bunches (EFB) to the field as a source of K as well as to improve soil organic matter content. This organic material, as well as the heaps of cut fronds obtained during oil palm fruit harvesting, which are placed in the palms inter-rows, is good for soil amelioration. Studies need to be conducted on the effects of these organic materials on P uptake by oil
palm in order to understand the soil-P-organic material interactions in making P more available. This will help elucidating the role of organic amendments in tropical soils to increase P use efficiency by oil palms.

Overall Project Objectives

i. To evaluate suitable and cost-effective P fertilizer rates and sources for oil palms grown on different soil types and ecological zones in Malaysia;

ii. To study the management practices for P fertilizer application to increase P use efficiency;

iii. To study the effects of organic residue amendments (legume covers, EBF, cut fronds and palm oil mill effluent) on PR solubility and efficiency of P fertilizer use by oil palm;

iv. To evaluate methods of fertilizer and soil P analysis and correlate with P uptake and yield of oil palm;

v. To measure residual P availability in relation to soil P fractions, leaf P content and fresh fruit bunch (FFB) yield;

vi. To study the soil P pools and processes affecting PR dissolution and P availability.

Proposed Research Projects

The following 3 projects were defined to be carried out for achieving the above objectives:

Project A: Evaluating different P fertilizer sources and methods of application on P uptake and FFB yield. The proposed experiments to be conducted to achieve objectives i, ii and iv were:

1. Economically efficient rate of phosphate fertilizer application for oil palms planted on deep peat (Mr. Chang Ah Kow and associates - Tradewinds Research and Development Centre);

2. Efficacy of sources and methods of placement of phosphate fertilizers on oil palm yield (Lim, CH and associates - FELDA Agriculture Services Sdn Bhd).

3. Utilizing the existing phosphate in soil and applied fertilizer phosphate under oil palm (Dr. Zulkifli Hashim and associates - Malaysian Palm Oil Board);

4. Phosphorus uptake, recycling and turnover in oil palm plantations (Prof. Zaharah and associates - Universiti Putra Malaysia).

Project C: Effect of PR on legume cover establishment and organic P release and utilization by oil palm. The proposed experiments to be conducted to achieve objectives iii and iv were:

5. Efficiency of PR use and cycling in immature oil palm (Mr. Goh Kah Joo and associates - Advanced Agroecological Research Sdn Bhd);

Oil palm covers almost 3 million hectares in Indonesia, located either in large private and governmental plantation schemes, or belonging to smallholders. Except for the old plantations in North Sumatra, most of the main projects developed during the last 20 years have been located in new agricultural area, mainly in Sumatra and Kalimantan. Most of soils in these locations require high input of phosphate fertilizer in order to achieve potential growth and yield of the palms. Several fertilizer trials in Sumatra and Kalimantan have shown the superiority of soluble forms of phosphate fertilizer during the immature stages of growth, compared to less soluble ones, such as PR when applied traditionally in the palm circle or lightly broadcast in the inter-row. Differences between PR sources have been observed and shown to be due to differences in reactivity. Most probably, this high response is the consequence of high phosphorus requirement of immature palms for growth and development, as well as the low inherent phosphorus fertility of the soils.

Nonetheless, oil palm growers may still be interested in PR, as the price is more advantageous, if only its agronomic efficiency could be improved. Laboratory observations have shown that the availability of P from several PR sources is better when the soil organic matter content is higher.

The present project aims at studying the effectiveness of several sources of PR (having a range of reactivity) when phosphate rock is added with organic matter, along with several methods of application in order to check in the field the impact of organic matter on improvement in PR utilization.

Objectives
This project is aimed at improving the agronomical efficiency of PR applications in oil palm cultivation, compared to soluble phosphate forms through the following applied research:

- Determine the most efficient method of application, to take advantage of the high organic matter that is recycled in the field (frond heaps, empty fruit bunches (EFB)).
- Compare several sources of PR of different reactivity, in order to identify the most suitable source based on soil type and palm requirement for phosphorus at different stages of growth.

Experiments on mature palms
- The experimentation compared traditional phosphate fertiliser placement with an application of pruned frond heaps, compared to an application on EFB.
- Several sources of PR, ranging from low to high reactivity, are being tested on four types of soils (clay soils, sandy soils, acid sulphate soils, peat soils).
- Trials in first and second oil palm generation will be set up, as the P soil fertility is significantly modified with time.
- The advantage of using an enriched compost of PR with EFB is being determined.

Experiments on immature palms
The experiment is comparing several sources of PR (low and high reactivity) as well as phosphate fertilizer placement (application in palm circle with and without EFB).

Expected outputs
Agricultural practices related to phosphate fertilization in oil palm plantation will be proposed based on the results obtained in the initiated experimentation.

These agricultural practices will take into account the performance of different phosphate fertilizers and methods of application. In addition, the recommendations will take into consideration the type of soil and the stage of growth of the palms.

Output from Projects
Results for legume dry weight, P concentration and P content have been summarized and a paper was presented at the *XV International Plant Nutrition Colloquium* held on September 14-19 2005, Beijing, the People’s Republic of China.
PROMOTING IMPROVED AND BALANCED FERTILIZER USE IN POLAND

Field trials were conducted at Brody Research Station and farmer’s fields in Bodzewo, Wieszczyczyn, Ziemiecin and Donatowo. These trials tested different rates and combinations of N, P and K on selected crop rotations that are oilseed rape-winter wheat triticale, in Brody; sugar beet-winter wheat, in Bodzewo and Wieszczyczyn; sugar beet-spring barley; in Ziemiecin; and oilseed rape-winter wheat; in Donatowo. The N, P and K applications comprised a Farmer’s Possible Fertilization Practice Fertilization (PFP), and RBF (PAPR), where the P application is in the form of partially acidulated phosphate rock.

In June 2005, a visit by IMPHOS staff to the trials was organized by the Agricultural University of Poznan to assess the experiments conducted in Brody, Bodzewo, and Wieszczyczyn.

A summary of the results obtained in 2005 in some locations is given below.

The results this year show a significant effect of fertilizer treatments over the control for all crops tested and across all sites. However, some differences exist in the magnitude of the crop responses to P fertilizer applications depending on the sites.

Compared with the control, wheat grain yields more than doubled in Brody and Ziemiecin in response to various treatments. At Brody, rapeseed and triticale yields were also doubled by fertilizer applications.

PAPR application as a P source resulted in good yields compared with the other P sources, but the so-called PFP treatment resulted also in good harvests in general.

The technical qualities of some wheat grains and quality parameters of sugar beet in terms of molasses forming substances, were measured. The results showed that wheat grain total content of protein and gluten was significantly and positively affected by fertilizer treatments at all sites.

![Sunflower field]

![Rapeseed field]
Effect of Some Treatments on Wheat Grain Protein Content

Quality parameters such as polarization, sugar content, alpha-amino N, potassium and sodium contents, and recoverable sugar content of sugar beet were determined at all experimental sites. In Ziemiecin, the results showed increasing sugar content in treatments with high P application rates, i.e., RBF and RBF as PAPR. At this site, it was found that sugar beet fertilized with PAPR had the lowest level of melassogenic substances (alpha-amino N, potassium and sodium contents).

The Effect of Some Fertilizer Treatments on Sugar Yield at Ziemiecin

In Bodzewo field trial, fertilizer treatments did not have any effect on sugar beet yields. However, lack of P fertilization increased the contents of melassogenic substances; the highest losses in sugar yields were obtained with the RBF-P treatment and the lowest on the RBF and PAPR treatments. In Bodzewo field trial, fertilizer treatments did not have any effect on sugar beet yields. However, the lack of P fertilization increased the contents of melassogenic substances; the highest losses in sugar yields were obtained with the RBF-P treatment and the lowest on RBF and PAPR treatments.

EVALUATION OF DIFFERENT FERTILIZER RECOMMENDATION SYSTEMS ON VARIOUS SOILS AND CROPS IN HUNGARY

IMPHOS is progressing with its project undertaken jointly with the Research Institute for Soil Science and Agricultural Chemistry (RISSAC) and the Agricultural Research Institute of the Hungarian Academy of Sciences (RIA). This three-year project is carried out in three different ecological areas characteristic of Hungarian environmental conditions. The objective is to field test the RISSAC-RIA recommendation of cost-saving, environment-friendly system, as well as the intensive MEM NAK system and the other systems valid for Hungarian conditions. In 2004/05 season, field trials were conducted on corn at the following sites:

1. Balatonszentgyörgy: a brown forest soil, slightly acidic sandy loam, with medium-good P supply.
2. Nagyhörcsök-Sarhatvan: a chernozem soil, calcareous loam, with poor-medium P supply.

At Balatonszentgyörgy, corn yields were increased by 2.9, 0.6 and 0.5 t/ha in response to N, P and K applications, respectively. These responses indicated that the soil NPK fertility level were good, consistent with the NPK supply categories established in the recommendation system. The results showed that it is possible to reduce NPK application by around 50% of total NPK recommended by the intensive system (MEM NAK) without causing yield losses. Highest net profits were obtained with the integrated level (Talajeró), minimum (RISSAC-RIA-1) level and in the balance based (RISSAC-RIA-3) level (Figure 1). The optimum level to sustain high soil fertility and productivity is around 45 kg P₂O₅/ha.

The Nagyhörcsök-Sarhatvan corn yield surplus was 3.9, 1 and 0.6 t/ha respectively for N, P and K applications.

Field day visit to Nagyhörcsök-Sarhatvan, Hungary, September 2005
Responses to N, P, and K applications indicated the N, P and K adequate supplies, i.e., according to the NPK supply categories, established in the recommendation system. Minimum level (RISSAC-RIA-1) suggested only 39% of the total amount of NPK recommended by the intensive system (MEM NAK), meanwhile corn grain yields obtained with these treatments were equal. The results suggest that farmers can reduce NPK application quite substantially without causing yield losses or compromising soil fertility. In this case, the system suggests to the farmers to apply the environment-friendly level (RISSAC-RIA-2) which gives the highest net profits (Figure 6), around 60 kg P$_2$O$_5$/ha.

In Mezőkövesd, corn yield responses were to 1.6, 0.1 and 0 t/ha to N, P and K applications, respectively. Responses indicated the N, P and K supplies were more or less appropriate, i.e., consistent with NPK supply categories established in the recommendation system. Although soil P supply was medium, almost no P response was observed in the trial, probably due to liming in Autumn, 2003.

This field trial suggested that, although being at minimum level (RISSAC-RIA-1), only around 24% of the total amount of NPK recommended by the intensive system (MEM NAK), resulted in equal corn grain yields in these treatments. Highest net profits were obtained using the environment-friendly level (RISSAC-RIA-2), the balance-based level (RISSAC-RIA-3), and minimum level (RISSAC-RIA-1). The recommendation system suggests therefore a rate of 50 to 70 kg P$_2$O$_5$/ha is adequate in order not to compromise the long-term soil productivity.

Conclusions

The second year of the project, as with the first year, suggest again that the principles of the new, cost-saving and environment-friendly RISSAC-RIA fertilizer recommendation system for corn is sound and scientifically based. This new fertilizer recommendation system is based on correlations of data in the database collected from the Hungarian N, P, and K long-term fertilization trials and published between 1960 and 2000, unlike the intensive MEM NAK system. The new system recommends lower NPK doses, without causing yield and soil fertility reductions in the long-term, resulting in the highest net profits for the farmers. Indeed, the network would not recommend large amounts of NPK because they are not agronomically sound nor economically profitable and might even have adverse effects on the environment.

Since Autumn 2005, the new RISSAC-RIA fertilizer recommendation system has been used in the National Agro-environmental Program, as part of the National Rural Development Plan financed by EU.
ENVIRONMENTAL ISSUES

Among environmental issues raised in connection with phosphate fertilizer use, cadmium concentration has drawn much attention, but mainly in Western Europe.

The possible impact of fertilizer cadmium on the environment has been subject to a large number of scientific and technical contributions to knowledge about the "Cadmium Issue" in relation to the use of phosphate fertilizers in agriculture.

It is important to recall here that for the past several years, IMPHOS has been able to make considerable progress towards the advancement of scientific and technical knowledge about Cd, through organization of workshops, publication of papers, conduct of scientific, and technical desk studies, holding of several meetings and supplying relevant information to different Directorates General of the European Commission.

IMPHOS main activities in this area during 2005 can be summarized as follows:

IMPHOS expressed its position on this regulation proposal in letters addressed to DG Enterprise, by arguing:

● Any measures adopted must be entirely based on an appropriate analysis of risks to health and the environment from Cd in fertilizers.

● Therefore, a risk analysis must take into account all variables including, sources of Cd emissions, varying soil and climatic conditions as well as soil use and output in all EU Member States. This statement falls in line with the recommendations made by the Scientific Committee on Toxicity, Ecotoxicity and the Environment (SCTEE), in its opinion to DG Enterprise on a limit value for Cd in fertilizers.

● The issue of a European Regulation on Cd may prompt similar regulations in other regions, including those still struggling to develop agriculture to achieve food security.

In pursuit of solutions for the Cd in fertilizers, IMPHOS met DG Enterprise in June, 2005 and emphasized its
position on the Cd issue and its willing and availability to work with DG Enterprise, in search of mutually acceptable outcome.

In addition, IMPHOS met DG Agriculture and DG Trade and conveyed to them the same message communicated to DG Enterprise.

Furthermore, IMPHOS addressed letters to DG Agriculture and DG Trade to convey mainly information about a study on the use of phosphate rock as a source of mineral feed supplements to cattle diet in Senegal and the main SCTEE (Scientific Committee for Toxicity, Ecotoxicity and Environment) opinions concerning the Risk Assessment Report on Cadmium.

It shows that:

First, the negative effects of phosphorus and calcium deficiencies can be overcome by supplementing cattle with phosphate rocks as sources of calcium and phosphorus. This mineral supplement resulted in many gains in meat production and cattle reproduction.

Second, a set of information related to the opinion of SCTEE, mainly stressed that:

- A limit of Cd in fertilizers should be derived based on risk assessment approach, and take all Cd sources into account.
- There are no imminent risks to human health, based on these risk assessment studies, and it is advisable to hold on any decision until other reliable data are made available.
- The problem of Cd accumulation in agricultural soil is neither urgent nor acute, and is not uniform across the EU.

- There is uncertainty in the input-output data and it now appears that estimating Cd leaching losses is critical for drawing firm conclusions.

The numerous IMPHOS activities dealing with this issue are considered significant contributions to the issue of cadmium in fertilizers.

**PROSPECTS FOR OTHER USES OF PHOSPHATE PRODUCTS**

IMPHOS is in the process of addressing new applications of phosphorus compounds other than fertilizers. These include data processing, energy, health, food preservation and environment protection. Among potential applications with very high added value, the following are attracting the interest of the Institute:

- **New Titanium Oxy Phosphate Material for Lithium Batteries. Application: Mobile phones, laptops.**

- **Composite Membranes of Bacterial Cellulose and Sodium Polyphosphate. Applications: medical applications, dietary fibres, headphone membranes, special paper, protective layer in the construction of enzyme-based glucose sensors, fuel cells, etc.**

- **CdS and WO₃ (tungsten oxide) Nanoparticles in Eu⁺ doped polyphosphate Glasses. Application: Semiconductor doped glasses.**
Development of Phosphate Crystalline Materials for Radioactive Wastes Solidification Towards Increasing the Ecological Safety of their Storage and Disposal. Application: The wide isomorphism of cation, including those which might be presented in various combinations and quantitative ratios in wastes of the nuclear fuel cycles.

Effective Cellular Responses on Polarized Hydroxyapatites Vector Ceramics in Body Fluids. Application: Medical application, the Hydroxyapatites (Ca₁₀(PO₄)₆(OH)₂;HA) has an excellent biocompatibility and valuable electric properties.

Pd₂P₂O₇ and AuPO₄ - New Anhydrous Phosphates of Noble Metals. Application: Anhydrous Phosphorus can play the role of noble metal collectors, as: Gold, palladium and platinum.


Alkaline Polyphosphates. Application: Food preservation.

Phosphates play a role in ecological safety from radioactive waste.

Phosphates are used in laboratories as complexing agents.

Hard Polymer Compounds of Polyorganophosphazenes. Application: Substitute of silicone for medical application, Polymers used at high temperature for industrial application.

In addition, the Institute is assessing the significance of a number of other applications, including:

1. Food applications (French fries, vegetables, beverages, cereal products, egg products, fats and oils, noodles, toothpaste, etc.),
2. Technical applications (phosphate in detergents, softening and complexing agent, emulsifying agent, dispersing agent, buffer capacity, alkalizing capacity, etc.)
3. Metal treatment (cars, refrigerators, washing machines and several other painted or enamelled items),
4. Water treatment (polyphosphates can sequester the calcium and magnesium ions in soluble compounds),
5. Other applications such as ceramics enamels and refractory, porcelain, flame retardants, paints, glass, antifreeze agents, polystyrene, yeast and fermentation, etc.
Fertilizer is key input in agricultural productivity improvement. It has enabled food production to increase alongside population and economic growth. Phosphate is a nutrient which is part of the fertilizer package that remains the driving force for the growth of crop production, which is necessary to meet the global food demand.

The link between phosphate fertilizer and food must not go unnoticed; as the world cannot afford a communication breakdown. The fact that the public must know about the vital contribution of the phosphate industry to improved diets for people everywhere and their hopes for a better standard of living underpins IMPHOS involvement in various communication efforts.

IMPHOS PHOSPHATE NEWSLETTER

The Newsletter reports on a wide range of IMPHOS projects involving phosphate fertilizer use for sustainable crop production. In 2005, three issues (Nos. 22-24) were published and widely distributed. They reported a wide variety of subjects. Under the heading "IMPHOS Today", current activities of the Institute, including the latest phase of a 10-year old project in Pakistan and several workshops held in India, Pakistan, Poland, Hungary and Romania were well covered. The project in Pakistan helped the resource-poor farmers learn how to grow more wheat (+35% yield increase) using balanced fertilization practices. In the one-day IMPHOS workshop in Ranchi, India, participants learned about the significance of phosphorus in balanced nutrition of cereals, pulses and oilseeds, as demonstrated by an extension project promoting efficient fertilizer use.

In addition, the Newsletter recurring themes under the headings of "Best Available Technologies" (BAT) and "Best Management Practices" (BMP) focussed on fertilizer production and application technologies, respectively.

The Newsletter issues can be downloaded from the IMPHOS website.

IMPHOS WEBSITE

IMPHOS operates a website (www.imphos.org) that enables visitors to the site to download PDF versions of its numerous publications on-line. The site also allows for easy navigation from one section to another and announces new forthcoming events planned by the Institute. One such event was the workshop on phosphorus compounds that took place in Japan in September, 2005.

IMPHOS-FAI AWARD

Considering the long involvement of the Institute in India, it launched in 2001 with the help of the Fertilizer Association of India (FAI) the contest for IMPHOS-FAI Award, to publicize and encourage applied research on phosphorus that might help farmers. Thus, for this award, the theme of "The Role of Phosphorus in Improving the Yield and Quality of Crops" was chosen. Scientists and experts working in India were invited to run for the award in an announcement in the FAI "Fertiliser News" Journal. Based on assessment of their published work, the first winner of the Award was recognized at the Annual FAI Seminar held in Delhi in December 2002.
For the 2005 Award, the winners were a team of scientists who have made a significant contribution towards phosphorus management under various cropping systems. Dr. P. K. Ghosh, Dr. M. C. Manna, and Dr. K. K. Bandyopadhyay, working on phosphate management at the Indian Institute of Soil Science in Bhopal, were recognized for their scientific work, generating data that can be used by farmers to improve their food crop yield and quality.

**ENHANCING AWARENESS**

Every time there is an issue that compromises the image of the phosphate industry, IMPHOS is keen to counteract with data and facts that set the record straight. For example, the precautionary principle used in Western Europe, shifts the responsibility from the authorities that must prove that something is harmful, to the industry to prove that it has absolutely no risk. In this process, little attention is paid to the benefits. It is the duty of the phosphate industry represented by IMPHOS to show the link between the food in the supermarket and the farmers who produce it, using fertilizer to improve both nutritional quality and availability of that food.

**WORKSHOPS, FIELD DAYS, CONFERENCES AND SYMPOSIA**

IMPHOS organizes periodically international seminars, regional workshops, and field days. Several of these were organized in 2005:

1. **Workshop on "Agriculture and Environment" in Poland (June, 2005)**

   Held on June 18 in collaboration with the International Potash Institute (IPI), the workshop in Bierzglinek, one of the best agricultural regions of Poland, attracted more than 300 participants: farmers, students, extension agents, sales managers of agricultural inputs, and those specifically involved in fertilizers and plant protection. They addressed topics ranging from soil acidity and limiting to plant protection and seed production, but emphasized potassium and phosphate in balanced fertilization and environment protection.

   This event met with great success, and plans now are well in progress to organize a second workshop in 2006 jointly with IPI and the Agricultural University of Poznan (AUP) in Poland, for training extension agents and fertilizer dealers.

   In addition to the workshop, a guided tour through field trials (field day) was also organized.

2. **Field Days in Hungary (August-September, 2005)**

   Open field days were organized at trial sites in Mezőkövesd (August 31), Sarhatvan-Nagyhórcsök (September 1) and Balatonszentgyörgy (September 2). In each of the field days, some 8 to 25 people participated from universities and research institutes, as well as soil and plant analysis laboratory networks and the farming business. Some people came a long distance to check how the environment-friendly and cost-saving fertilizer recommendation system works under field conditions. This new RISSAC-RIA system supported by IMPHOS was welcomed in Hungary where it was used on 75,000 hectares, thanks to the new EU Agro-Environmental Program in 2005. The fertilizer industry as well a sugar factory in East Hungary and five county agricultural chambers purchased the relevant software and made use of the new fertilizer recommendation system.

   In conclusion, the workshop was a success in terms of turnout of experts from the laboratory network and the larger number of soil tests performed compared to previous year.
3. Publications in Hungary

Data from IMPHOS field trials with winter wheat were published in a book* in the chapter "Principles of sustainable plant nutrient management". The book* was printed in one thousand copies. Also, two papers were prepared for publication in 2004 and 2005 in the farmers’ monthly magazine "Agronaplo". The 23rd issue of the IMPHOS Phosphate Newsletter reflected well these activities.

4. International Conference on Phosphorus and Phosphate Compounds, Kasugai, Japan, September 2005

The IMPHOS Strategic Plan of Action 2001-2010 calls for resumption of the traditional series of conferences on "Phosphorus compounds" organized previously in Rabat, Boston, and Brussels. In compliance with this plan, an international workshop on "Phosphates: New Uses and New Technologies" was co-organized by IMPHOS and the Japanese Association of Inorganic Phosphorus Chemistry (JAIPC) in Jena (Germany) in July 2002.

As a result of their successful joint undertaking, IMPHOS and JAIPC decided to again hold on 6-8 September an international conference in Japan on Phosphorus and Phosphate Compounds, in connection with the 5th International Symposium on Inorganic Phosphate Materials (ISIPM-5). The scientific program consisting of 25 papers and 85 poster presentations, attracted an audience of about 140 participants from 16 countries.

The IMPHOS presentations to the scientific community in this workshop covered phosphate mining and chemical processing activities, as well as the vital role of this nonrenewable natural resource to sustain crop production and meet food requirements of the world population. Environmental issues arising from mining and industrial activities were also reviewed in the IMPHOS presentation.

Other presentations covered a wide range of new phosphate-derived products other than fertilizers, as well as the latest developments in fundamental phosphate-related research on glasses and glass-ceramics, apatite and biomaterials based on phosphates, optical phosphate materials, ionic and electronic conducting phosphate materials, phosphorus and nitrogen containing materials and environmental science and technology of phosphates, not to mention polyphosphates as flame-retardants.


Field Day visit to Mezökövesd trial, August 31, 2005

Canned food with P additive
5. Symposium in Romania on Plant Nutrient Management for Better Crop Quality and Environment (July, 2005)

This symposium held in Craiova (Romania) on 13-14 July dealt with 1) phosphorus and potassium for the quality of field crops and special crops, 2) cultivation systems for producing quality crops, and 3) nutrient management systems under environmentally sustainable conditions, with a focus on phosphorus and potassium.

The various sessions emphasized the efficient use in crop production of NPK fertilizers, as well as the application methods and techniques conducive to better crop quality.

The second part of the Symposium consisted of a field visit to the Caracal-Dolj Agricultural Research and Development Station where several experiments were conducted on the use of fertilizers on arable crops and fruit trees. Another visit to learn about research on the application of new liquid fertilizers to crops growing on sands under sprinkler fertigation, took place at the Dabuleni-Dolj Research and Development Station for plants growing on sands.

The papers and discussions emphasized the important role that fertilizers play, both in Romania and other Central European countries, in maintaining and enhancing soil fertility and crop yield and quality. When fertilizers are properly managed to meet soil fertility and crop nutrient requirements, their adverse impact on the environment can be minimized or completely circumvented.

Indeed, sustainable agriculture cannot be practiced without proper management and adequate use of fertilizer nutrients at sufficient levels to restore the reserves of soil nutrients taken up by crops. For the future, extension work is necessary to disseminate information on improved fertilizer management practices, including good application methods and techniques. The need was also felt to promote the application of "new" fertilizers when available and where needed, and soil testing to determine plant nutrient requirements and avoid adverse effects on the natural environment.

The Symposium concluded with the following recommendations:

1. Setting up a special program to support soil survey and soil testing and promote balanced fertilization in order to recover the high levels of crop production;
2. Enabling farmers through a farmer-support system to fertilize their crops in proportion to expected yields;
3. Providing financial incentives and support to fertilizer plants to enable them to modernize production technologies and facilities, produce new fertilizers, reduce...
energy consumption and production costs, lower fertilizer prices, and reduce impact of effluents at production sites;

4. Supporting the organization of national and international conferences, symposia, and exhibitions that highlight those opportunities for fertilizer use to enhance crop quality and soil fertility;

5. Increasing the number of field demonstration trials involving fertilizer management under different agro-environmental conditions.

The symposium was attended by 72 researchers, teaching staff, experts in agriculture, the fertilizer industry and farmers. It was particularly appreciated by all the participants for its topics, exhibited posters, distributed leaflets and exhibits.

6. Workshops in Uttar Pradesh and Himachal Pradesh, India (December, 2005)

As part of the Institute’s efforts to enhance phosphate fertilizer use in India, it organized two workshops and a field day in Uttar Pradesh (at Kanpur) and Himachal Pradesh states of India in December, 2005.

The Workshop In Kanpur was convened jointly with CS Azad University on 5 December in connection with the annual seminar of the Fertilizer Association of India (FAI). It was an opportunity to report the findings from various IMPHOS projects in India to a diversified audience coming from the fertilizer industry, extension services, universities, Department of Agriculture, farmers, local press and media, and international agencies (Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre). At the research station of the University, participants got involved in an elaborate program: The importance of P in plant nutrition, salient findings from IMPHOS project in Uttar Pradesh, feedback from the farmer group, and the package of practices for kharif crops (Crop varieties, fertilizer use, disease and pest control, economics).

IMPHOS also organized a workshop and farmers’ field day at Harec Bajaura in the State of Himachal Pradesh (HP), on 7 December, 2005. The program involved an introduction of IMPHOS projects in Asia, in addition to topics such as the importance of phosphorus in plant and status of fertiliser use in H.P., organic farming research, potential off-season vegetable crops of H.P., salient findings from IMPHOS project in H.P., and feedback from the farmers’ group.

H.E. the Minister of Agriculture in Himachal Pradesh was briefed by IMPHOS staff about the institute activities in India and the region in general. For both events, the local press was invited to cover IMPHOS activities in India, and several leaflets were printed in the local language and distributed widely in each State for public information about the results of the project.
7. Farmer’s Field Days in Pakistan

Farmer’s field days and meetings were arranged at the demonstration sites in 2005 and throughout the country: Punjab, Sindh, Balochistan and N.W.F.P. provinces. They were an opportunity to demonstrate to farmers the actual crop response onsite to efficient and balanced fertilization, so that they can compare their own practices with recommended practices, both in terms of economics and better yield, as ‘seeing is believing’.

INTERNATIONAL COOPERATION

This is a very significant area of IMPHOS work to the extent that the challenges facing the phosphate industry today require broad-based cooperation among different stakeholders. IMPHOS has built working relationships and strategic alliances with several organizations, in order to respond adequately to the challenges and insure sustainable phosphate production and use. It has concluded one such agreement with IFFCO, a significant producer and distributor of fertilizer and provider of advisory services in India. Similarly, IMPHOS has established strategic working relationships with the International Potash Institute, paving the way for the organization, as described above, of several joint workshops, symposia and field research projects in Eastern and Central Europe.

FERTILIZER ASSOCIATIONS WORKING GROUP

IMPHOS participated in the FAO/Fertilizer Associations Working Group in Rome, Italy (28-29 June). Since the establishment of this Group in 1968, FAO has maintained an extensive database on supply/demand in cooperation with the international fertilizer industry. IMPHOS representatives have participated regularly and actively in the Group meetings devoted to the preparation of annual fertilizer nutrient supply and demand balances. This year, the world and regional balances covering the past two years (2003/04 and 2004/05) together with forecasts for the next five years were published in a booklet under the title "Current World Fertilizer Trends and Outlook to 2009/10", by the Information Division of the FAO.

In conclusion, IMPHOS has endeavoured to enhance the collection and dissemination of relevant information, the communication of targeted messages, and the establishment of good working relationships with international organizations. In this regard, it has attempted to fulfill its mandate, both as a scientific institute and a spokesperson for the phosphate fertilizer industry. Many prestigious research institutions, scientific bodies and government and non-government agencies were keen to provide advice to IMPHOS. The Member Companies are the ultimate beneficiaries of the accomplishments of IMPHOS, but the fertilizer industry as a whole and its farmer clients stand to benefit from the activities and services of the World Phosphate Institute.
PHOSPHATE PRODUCTION AND USE

PHOSPHATE ROCK

The world reserves of phosphate rock, meaning deposits that are or could be profitably mined under prevailing costs, market prices and technology, are limited. They were estimated by the US Geological Survey in 2001 at 11 billion tonnes, concentrated mainly in IMPHOS Member Companies in Morocco (5.9 billion tonnes), Algeria, Tunisia, Jordan, Senegal and Togo. The reserve base was estimated at about 36 billion tonnes (Figure 1 & 2).

More than 75% of the world’s commercially exploited phosphate rock is surface mined using techniques that vary from labor intensive methods to highly mechanized technologies. The remaining rock is recovered by underground mining. The phosphate content in currently mined rocks can range from over 40% to below 5% P₂O₅. The mined rock is further processed to remove the bulk of the contained impurities and thus upgrade the rock. The beneficiation process usually allows a concentration of around 1.5 times but higher ratios are needed with some rocks. After beneficiation, the P₂O₅ content of the phosphate rock concentrate generally ranges from 26% to about 34% but can be up to 42%. Higher P₂O₅ content equates to less impurities, larger yields per tonne of material shipped, handled and processed, increased reaction efficiencies, fewer processing problems and less waste.

Notwithstanding these advantages, the average rock quality has been declining, as high-quality reserves are not replaced at the same rate as those of lower quality. This situation will lead to production readjustments in the near term.

Production and Use: Phosphate rock production in 2005 was significant. It was estimated at around 163 million tonnes, nearing the peak level of 166 million tonnes produced in 1988. The U.S., Russia, Tunisia, Egypt and China accounted for the bulk of the increase in 2005 (Figure 3).

Over 30 countries are currently producing phosphate rock for use in domestic markets and/or international trade. However, the world’s top 12 producing countries account
PHOSPHORIC ACID

Production: Phosphoric acid is obtained mainly by reaction between phosphate rock and sulfuric acid. In 2005, global phosphoric acid production registered a 4% increase over 2004, to 33.5 Mt P₂O₅. Most large producers, including those of IMPHOS, increased their phosphoric acid production in 2005 (Figure 5).

PHOSPHATE FERTILIZERS

More than 99% of all phosphate fertilizers are derived from phosphate rock. Some 85% of world phosphate fertilizers are manufactured by reacting phosphate rock either directly with sulfuric acid or indirectly with phosphoric acid produced using sulfuric acid. The reactions increase the nutrient concentration in the final product and make the phosphorus available to plants on nearly all soils.

During the past 30 years, a large proportion of the increase in phosphate fertilizer production has been in the form of phosphoric acid based fertilizers, mainly ammonium phosphates (DAP and MAP).

Global DAP production in 2005 was estimated at 12.8 Mt P₂O₅, representing an increase of 0.5 Mt over 2004. Higher production was reported in the United States, Morocco and China. Global MAP production in 2005 was estimated at 7.5 Mt P₂O₅, while global TSP production stood at close to 2.8 Mt P₂O₅ (Figure 6).
PHOSPHATE TRADE

Phosphate rock: Initially, the main form of traded phosphorus was phosphate rock, but the trade in phosphate rock has declined sharply over the last 20 years as vertically integrated industries have been developed at or close to the site of the mines. World phosphate rock exports fell from 53 million tonnes product in 1979 to 27 Mt in 1993. Another net decline of 4.5 Mt in global rock trade was registered between 1998 and 2003. The year 2004 saw a reversal of this trend with a significant 6 per cent increase over 2003.

Morocco remains the world’s largest rock exporter with a 42 per cent share of global exports, followed by Jordan. While deliveries from other main exporters declined in 2005, notably from China, Russia, Jordan and Togo, Moroccan rock exports were estimated at 13.5 Mt (figure 7).

Processed Phosphates: In contrast to phosphate rock, world trade in phosphoric acid and phosphate fertilizers has increased substantially over the last thirty years. Among major exporters, three IMPHOS Members (Morocco, Tunisia, Jordan), in addition to South Africa, increased their exports in 2005.

Indeed, DAP exports rose by 9 per cent to 5.8 Mt P2O5, but MAP global trade dropped by 9 per cent to 3.0 Mt P2O5 in 2005 (figure 6). The USA dominates the world DAP market, while Russia is the main player in the MAP market (Figure 8).

GLOBAL PHOSPHATE SUPPLY/DEMAND SITUATION AND OUTLOOK

Current Situation

Phosphate rock: World phosphate rock capacity continues to expand to meet the growing demand of the fertilizer and industrial sectors. China accounts for the bulk of the increase (Figure 9).

Table 1: World trade in phosphoric acid and main phosphate fertilizers

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Phosphoric acid</td>
<td>3.8</td>
<td>4.4</td>
<td>5.0</td>
</tr>
<tr>
<td>Ammonium Phosphates</td>
<td>4.2</td>
<td>8.3</td>
<td>8.8</td>
</tr>
<tr>
<td>Triple Superphosphate</td>
<td>1.6</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Total</td>
<td>9.6</td>
<td>14.1</td>
<td>15.4</td>
</tr>
</tbody>
</table>
Phosphoric acid: Phosphoric acid supply exceeded demand by nearly 5%; as there was a firm recovery of phosphate fertilizer production. The global demand for fertilizer phosphoric acid is estimated at 26.7 Mt P$_2$O$_5$ in 2005, and the global phosphate market was relatively balanced (Figure 10).

Several new projects are expected to come on stream in the near future, with developments announced in various regions. The majority of this increase will be dedicated to local downstream production, with little impact on the availability of acid for exports. The result is that global phosphoric acid capacity is forecast to increase by an overall 13 per cent, to 49 Mt P$_2$O$_5$ in 2009. Close to two-thirds of the global capacity additions is expected to be located in China. Other capacity additions are planned in Brazil, India, Morocco and Tunisia. On the other hand, global demand of phosphoric acid for fertilizers is predicted to be close to 31 Mt P$_2$O$_5$ in 2009 (compared to 26.7 Mt in 2005), considering that most of the increase in the demand for phosphate fertilizers will be based on phosphoric acid.

Phosphate Fertilizers: Following a difficult period for the phosphate industry in 2003, the situation improved in 2004 and 2005 as global demand improved. DAP capacity will continue to increase from 20 Mt to 23.5 Mt P$_2$O$_5$ over the period 2004 to 2009. China will be the largest contributor to the growth, but capacity additions will occur also in Brazil, India and Morocco.

During the period 1993/94 to 2002/2003, annual world total phosphate fertilizer consumption increased from 29 to an average of 34 million tonnes P$_2$O$_5$. Consumption in North-east Asia, South Asia and Latin America increased, that of West Europe stabilized while demand in Eastern Europe and Central Asia fell again. After growth to 35 Mt in 2003/04, phosphate fertilizer demand remained firm. It grew in 2004/05 by 5.5% to reach 37 Mt P$_2$O$_5$, approaching the 1988/89 peak level of 38 Mt P$_2$O$_5$.

**Supply/Demand Outlook**

Global: As far as agriculture is concerned, cereals play a central part in human diet. Today, half of the world's cropland is devoted to cereals. Wheat, rice and maize (coarse grain) are the major users of fertilizer and together account for over 50% of all global NPK fertilizer use.

Exceptional harvests were registered for almost all crops in 2004/05. This is the second largest crop ever after the record harvest in 2003/04. However, the aggregate cereal output would not be sufficient to cover the anticipated demand and would therefore result in a contraction of global cereal inventories (Table 2).

<table>
<thead>
<tr>
<th>Year</th>
<th>Wheat</th>
<th>Coarse Grains</th>
<th>Rice (Milled)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003/04</td>
<td>560.6</td>
<td>939.9</td>
<td>391.2</td>
<td>1 891.8</td>
</tr>
<tr>
<td>2004/05</td>
<td>625.9</td>
<td>1 023.9</td>
<td>405.0</td>
<td>2 054.2</td>
</tr>
<tr>
<td>Change</td>
<td>+11.6%</td>
<td>+8.9%</td>
<td>+3.5%</td>
<td>+8.6%</td>
</tr>
</tbody>
</table>
During the period from 2004/05 to 2009/10, the global P2O5 fertilizer demand is projected to steadily grow, reaching 40.7 Mt in 2009. This trend is justified by increasing global food, feed and fiber production: 1) The rising income along with urbanization in developing countries will encourage more meat consumption, which will stimulate strong growth in maize production. 2) a fast-growing demand for bio-energy crops 3) Gains in nutrient use efficiency only partly counterbalance growing nutrient requirements. For these reasons, phosphate fertilizer demand is projected to grow. It will grow faster than nitrogen fertilizer consumption because of the unbalanced NPK ratio (1:0.413:0.306 in 2004/05). However, compared to past forecasts, fertilizer demand in East Asia (driven mainly by China) is projected to significantly slow down and to stabilize at about 30% share (12.3 Mt in 2009/10) of global demand of phosphate fertilizers, most of which will be based on phosphoric acid (Figure 11).

Regional:
The world was divided into three categories:

First, the regions with P2O5 consumption of less than 1Mt include Africa, Central Europe (CE), Eastern Europe and Central Asia (EECA), and North-east Asia. In the short-term, moderate growth of phosphate consumption is expected in EECA. While fertilizer demand in the region is seen to continue to recover, with phosphate growing faster than the consumption of other nutrients, and while there is policy to boost agricultural production and cereal exports from the region, domestic consumption will largely depend on economic reforms and the pace of these reforms.

In comparison, African agriculture is still facing a number of structural problems in several countries. Issues curbing agriculture in Africa include 1) subsidies of agricultural products in rich countries, 2) lack of purchasing power to generate returns for agriculture, 3) inadequate infrastructure which leads to high costs of securing inputs, 4) storage and transport of outputs to markets, 5) weakness of enabling policies and support services that could make agriculture an attractive investment opportunity, 6) risky and unstable environment arising from civil disorder or war. Nonetheless, there is growing awareness of the urgent need to restore soil fertility and the importance of fertilizers is acknowledged by many policy makers. Development of supportive policies and functioning input and output markets is expected to drive regional fertilizer consumption up, though from a low basis.

Central Europe recovered significantly from the 2003/04 grain harvest, which was deeply impacted by adverse weather conditions. Phosphate fertilizer demand in Central Europe is seen to be increasing slowly from its low base.

Similarly, after the poor 2003/04 harvest in North-east Asia, rice production in Japan and Korea strongly recovered, but the region’s fertilizer consumption continued its declining trend. Rice area will shrink, and environ-
mental regulations will put pressure on fertilizer use, resulting in the steady reduction in phosphate demand (Figure 12).

**Second**, in 2003/04, West Europe enjoyed an exceptional harvest because of favorable weather conditions during the whole season, high agricultural commodity prices, and the temporarily halving of the mandatory set-aside. However, in the short-term, regional fertilizer demand is expected to resume its downward trend.

Phosphate use should continue growing in the Middle East as a result of irrigation schemes and supportive national policies. The huge land reclamation project in South Egypt will increase sharply the national cultivated area. Similarly, the Great Anatoliana Project is expected to significantly increase the irrigated area in Turkey in the years to come.

South-east Asia will continue to witness expansion of the oil palm area. Besides, the strong rice prices should be the main drivers of demand for phosphate fertilizers, in particular in Thailand, Malaysia, and Indonesia. While in Oceania, growth is more erratic as the main driving factor for fertilizer consumption will remain the weather variability, particularly in Australia (Figure 13).

**Third**, the regions with current P₂O₅ consumption of less than 5Mt include North America, Latin America, and South Asia. Strong increase in fertilizer demand occurred in North America in 2003/04, but it will slow down over the next five years. Significant shifts in crop mix are projected, with more maize and less soybean in the USA. Besides, cuts are expected in farm support spending by 3%, driven by concern over the huge US budget deficit and strong pressure from trading partners.

In Latin America and the Caribbean, the increase of regional fertilizer consumption is essentially driven by Brazil and, to a lesser extent, by Argentina. Both countries are expected to strengthen their position as key players in the agricultural commodity market. Expansion of the soybean cultivated area through conversion of degraded rangeland will continue and yield could still be increased through application of modern technology. Thus, it is likely to see more soybean and cereals in Argentina, and more soybean, sugarcane, and cotton in Brazil. In this context, the region’s fertilizer consumption is forecast to further increase in the next five years, but at a rate slower than in the past.

In South Asia, India is leading fertilizer demand in the region. Although it is still recovering from the drought season of 2002/03, it has had impressive growth in fertilizer consumption, particularly of phosphates (4.1 Mt P₂O₅ in 2003/04). In a five-year perspective, the highest growth in volume of demand is expected in South Asia, a growth which comes next only to East Asia’s. The region feels the need to increase food supply and to balance nitrogen fertilization with more phosphate applications (Figure 14).
BOARD OF DIRECTORS

The Board of IMPHOS held its annual meeting on 6 June 2005 in Kuala Lumpur, Malaysia to discuss the institute’s performance during the year 2005, and to consider work plans and budget for the year 2006. The Board particularly discussed the present status of the draft regulation of cadmium in phosphates under consideration by the European Commission, the trends in global P₂O₅ use, and the various projects of the Institute to expand phosphate use in Asia, Central and Eastern Europe, West Asia and North Africa, and sub-Saharan Africa.

The Board commended IMPHOS for making sterling efforts on the long-running issue of cadmium in phosphate fertilizers and working hard to promote the efficient use of P₂O₅ worldwide. It stressed the need for communicating stronger messages on diverse actions that the Institute pursues to deal with environmental issues confronting the phosphate fertilizer industry.

The Board adopted the 2006 work plan consisting of broad fieldwork and partnerships (in Asia), regional award (to be launched in Central and Eastern Europe), and technical studies (major phosphate derivatives and phosphoric acid technology). The implementation of IMPHOS research project portfolio implies intensification of the institute’s strategic partnership, the Board concluded.

THE AGRONOMIC AND TECHNICAL COMMITTEE

The committee reviewed the latest development in relation to European Commission new proposal on fertilizer content of cadmium in phosphate fertilizers and working hard to promote the efficient use of P₂O₅ worldwide. It stressed the need for communicating stronger messages on diverse actions that the Institute pursues to deal with environmental issues confronting the phosphate fertilizer industry.

In December 2005, the Agronomic and Technical Committee (ATC) reviewed extensively the most recent activities of the IMPHOS Scientific Advisory Committee (ISAC) and suggested broadening its membership to include people with a considerable experience in fertilizer technology. In addition, the ATC reviewed the ISAC draft position paper on "Setting major priority areas for the research activities of IMPHOS". ATC is of the view to amend these proposals in order to bring them to focus more with the principal mission of IMPHOS; which is to promote the use of P₂O₅.

The committee reviewed thoroughly the technical and agronomic performance in 2005 and made several comments and recommended regular organization of symposia or conferences on phosphorus and phosphates compounds. It considered the 2005 synthesis report summarizing more than 10 years of activities in Pakistan, recommended the preparation of similar synthesis reports to cover projects being conducted for many years now in countries such as India, Indonesia, Vietnam, etc.

Following the successful launching of the IMPHOS Regional Award for Eastern and Central Europe (2005) and the IMPHOS-FAI Award (2001), the ATC considered that thought should now be given to organizing an...
International Award for the scientific community in order to publicise the Institute’s work at international level.

**THE SCIENTIFIC ADVISORY COMMITTEE**

In its meeting in mid-March 2005, the IMPHOS Scientific Advisory Committee (ISAC) discussed an "Overview of fertilizer use in Vietnam: possible future research activities" pursuant to an oral presentation made by one of its members. The presentation showed the trends in fertilizer consumption in Vietnam (1980 to 2004), considered the average nutrient application per hectare and by crop, and fertilizer production and imports (2003 and 2004). The presentation outlined some possible avenues of research: balanced fertilization, use of magnesium and sulphur on industrial crops, and zinc in rice production; which would improve P fertilizer use efficiency and therefore actual crop yields.

The Committee also reviewed on-going activities, and discussed a set of possible projects/activities that IMPHOS might consider developing and implementing in the near future, i.e., from 2006 to 2009. These projects include the implementation of field experiments, desk studies as well as workshops, symposiums and conferences.

The Committee held a meeting at the end of November 2005 to discuss and share views on "Fertilizer use in West Asia and North Africa (WANA)". The topic was introduced in an oral presentation by a member of the committee. It addresses the exiting agricultural systems in the region and the socio-economic issues (rising incomes and urbanization) that impact fertilizer use and crop production in the WANA region. Research achievements and shortcomings, and constraints to the technology transfer to farmers were highlighted. Discussion involved the emergence of zinc and boron deficiencies in some crops, and the prospects for increased fertilizer use, mostly driven by fruit crops and protected crop production.

The Scientific Committee provided guidelines for pooling and interpreting the data collected during the course of the project conducted in Pakistan, in collaboration with FAO and NFDC (National Fertilizer Development Center). It made some recommendations on the planning and conduct of desk studies that focus on major P derivate products other than fertilizers, on phosphoric acid processing technology, and the preparation of the IMPHOS Annual Report for the year 2005. The Committee critically reviewed and amended the set of documents drafted for the regional IMPHOS Award for East and Central Europe.
### Abbreviations and acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>AFA</td>
<td>Arab Fertilizer Association</td>
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<tr>
<td>ATC</td>
<td>Agronomic and Technical Committee</td>
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<tr>
<td>BAT</td>
<td>Best Available Technologies</td>
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<tr>
<td>BF</td>
<td>Balanced Fertilization</td>
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<tr>
<td>BMP</td>
<td>Best Management Practices</td>
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<tr>
<td>Cd</td>
<td>Cadmium</td>
</tr>
<tr>
<td>CE</td>
<td>Central Europe</td>
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<tr>
<td>CPA</td>
<td>Crop Production Area</td>
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<tr>
<td>CSTEE</td>
<td>Comité Scientifique sur la Toxicité, l’Ecotoxicité et l’Environnement</td>
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<tr>
<td>DAP</td>
<td>Diamonium Phosphate</td>
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<tr>
<td>EECA</td>
<td>Eastern Europe and Central Asia</td>
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<tr>
<td>EFB</td>
<td>Empty Fruit Bunches</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>FAI</td>
<td>Fertilizer Association of India</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>FFB</td>
<td>Fresh Fruit Bunches</td>
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<tr>
<td>IAEA</td>
<td>International Atomic Energy Agency</td>
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<tr>
<td>ICARDA</td>
<td>International Center for Agricultural research in the Dry Areas</td>
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<tr>
<td>IFA</td>
<td>International Fertilizer Industry Association</td>
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<tr>
<td>IFFCO</td>
<td>Indian Farmers Fertiliser Cooperatives</td>
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<td>IMPHOS</td>
<td>Institut Mondial du Phosphate</td>
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<td>IPI</td>
<td>International Potash Institute</td>
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<td>ISAC</td>
<td>IMPHOS Scientific Advisory Committee</td>
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<td>JAIPC</td>
<td>Japanese Association of Inorganic Phosphorus Chemistry</td>
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<tr>
<td>MAP</td>
<td>Monoammonium Phosphate</td>
</tr>
<tr>
<td>MEM NAK</td>
<td>Intensive System</td>
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<tr>
<td>Mt</td>
<td>Million tonnes</td>
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<tr>
<td>NFDC</td>
<td>National Fertilizer Development Centre</td>
</tr>
<tr>
<td>NWFP</td>
<td>North West Frontier Province</td>
</tr>
<tr>
<td>PAPR</td>
<td>Partially Acidulated Phosphate Rock</td>
</tr>
<tr>
<td>PDF</td>
<td>Portable Document Format</td>
</tr>
<tr>
<td>PFP</td>
<td>Possible Farmer’s Practice</td>
</tr>
<tr>
<td>PR</td>
<td>Phosphate Rock</td>
</tr>
<tr>
<td>RBF</td>
<td>Recommended Balanced Fertilization</td>
</tr>
<tr>
<td>RIA</td>
<td>Agricultural Research Institute of the Hungarian Academy of Sciences</td>
</tr>
<tr>
<td>RISSAC</td>
<td>Research Institute for Soil Science and Agricultural Chemistry</td>
</tr>
<tr>
<td>Rs</td>
<td>Roupies</td>
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<tr>
<td>SCOPE</td>
<td>Scientific Committee on Problems of the Environment</td>
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<tr>
<td>Talajerò</td>
<td>Integrated Fertilization</td>
</tr>
<tr>
<td>TSP</td>
<td>Triple Superphosphate</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>USSR</td>
<td>Union of Soviet Socialist Republics</td>
</tr>
<tr>
<td>WANA</td>
<td>West Asia and North Africa</td>
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</table>
IMPHOS is a non-profit making Institute founded in 1973 by the world’s principal producers of phosphate rock. Its primary mandate is to collect and disseminate scientific data to support phosphate fertilizer management. This in turn will help increase crop yield and sustain crop production in such a way that the demand for food by the world’s population is met in a sustainable and environmentally acceptable way.

Among its objectives, IMPHOS seeks to promote increased and efficient phosphate use in both developed and developing countries, consistent with the principles of integrated plant nutrient management. The Institute also seeks to help improve farming practices conducive to larger crop yields and environmentally sustainable crop production.

World Phosphate Institute

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