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IMPHOS
PHOSPHATE NEWSLETTER

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IMPHOS TODAY

IMPHOS has New Chairman

Mr Mohammed BERRADA

Chairman of the World Phosphate Institifue

Mr. Mohamed BERRADA was appointed in November, 1999 by His Majesty King MOHAMMED VI as Director General(Chief Executive Officer) of the OCP Group. In this new capacity, he also succeeds Mr. Mourad Chérif as Chairman (Président) of the World Phosphate Institute.

Mr. Berrada holds a doctorate degree in economics from the University of Bordeaux and several diplomas from universities and institutes. His professional experience encompasses several areas, from academia to economic analysis, to industry and diplomacy, occupying eminent positions in the public and private sectors as university Professor, Minister of Finance, former manager of professional institutions and concerns, and most recently Ambassador of the Kingdom of Morocco to Paris.

Diagnostic technique and phosphate fertilization strategies for the mediterranean region*

➠ Rationale

Data from several laboratory and field experiments suggest that phosphorus is one of the most limiting nutrients to crop production in soils of the Mediterranean region. Therefore, it would be helpful to develop techniques that would enable farmers of the region to make proper use of P fertilizer to meet the demand of the plant-soil system, thereby increasing productivity and economic return.*(continued on p. 2)*

Crop responses and soil reactions to applied P fertilizers In West European countries*

In Western Europe, the buildup of soil P from intensive livestock farming is often so high that ground water contamination may become a serious problem. Furthermore, the European Union agricultural policy is putting economic pressures on farmers with regards to fertilize use, as it affected crop prices and introduced changes in land use. ***(continued on p. 4)***

CONTENTS

IMPHOS TODAY

B.A.T/B.M.P*

FLASH

* **B.A.T**: Best Available Technology in fertilizer production
B.M.P.: Best Managment Practices in fertilizer use.

Diagnostic technique and phosphate fertilization strategies for the mediterranean region*

(continued from p. 1)

To that effect, the World Phosphate Institute (IMPHOS) in collaboration with National Agricultural Research Centers in countries of the Mediterranean region set out to conduct a survey of phosphorus fertilization practices at farm level and to undertake under greenhouse a series of pot trials. This latter trials had two objectives : i) to compare soil testing methods for measuring plant-available P and ii) to determine possible fertilizer management strategies based on a diagnosis of the characteristics of soil and its crop production potential.

Approach

Through the survey, a mass of data was collected on :

- crop management practices followed over a period of 6-8 years in nearly 1,242 farm fields belonging to nine countries of the Mediterranean region: Algeria, Egypt, France, Jordan, Morocco, Spain, Syria, Tunisia, and Turkey.
- the general chemical and physical characteristics of soil samples collected from these fields, including their contents of clay, silt, sand, organic matter, total CaC03, active CaC03, total nitrogen, exchangeable cations….etc.
- available soil phosphorus, as measured by currently used soil testing methods in the above countries.
- Crop response to phosphate fertilizer application, by inference from various greenhouse trials and field experiments.

With the collaboration of “Laboratoire Europe Sols” in Toulouse-France, data processing obeyed the principles set out by the French Committee for Development of Efficient Fertilization (COMIFER). COMIFER proceeds in two stages as illustrated in Figure 1 :

1) The stage of diagnosis of crop requirement, fertilization history, crop residue management, and soil P content. Everyone of these variables is assessed and ranked into one of three classes, according to the particular set of agronomic conditions. Weighing these combined factors gives a fairly accurate idea of soil P availability and facilitates formulation of appropriate fertilization strategies. Three strategies are proposed to meet crop requirement: a) intensive fertilization to correct the level of available P in soil, b) maintenance fertilization to maintain the correct level of available P in soil, and c) withholding of P application over a period of time when it is not justified.

2) The stage of making fertilizer recommendations based on crop requirement and the apprapciate P fertilization strategy as defined above for each crop production condition of the region.

Main findings

The greenhouse research to estimate plant-available P involved a wide range of soils and five laboratory procedures. Correlations of chemical extractions of soil P to plant uptake indicated that $NaHCO_3$ extraction is the best procedure for predicting available P in calcareous soil.

Furthermore, in order to assess soil P availability for the whole Mediterranean region, several parameters were considered based on the COMIFER approach:

- Crop P requirement: crops were divided into three classes according to their P requirement: low, medium, or high (Table 1).
- Field fertilization history: It was determined based on both the balance of P application(F) minus crop removal(E) and the phosphorus fixing capacity of soils. Accordingly, fields were classified as having favorable, medium or unfavorable P fertilization history (Table 2).
- Crop residue management: The assumption is that all crop residues are removed from field and no P is restituted to the soil from such residues.
- Soil P content: Plant responses to P fertilizer application under greenhouse pot trials were used to assess soil P content. Over a wide range of soils of various characteristics, two values assumed much importance : i) the critical value (Tc) below which it is recommended to increase P application rate over the maintenance rate in order to build up soil P fertility, and ii) the sufficient value (Ts) above which it is recommended not to apply any P fertilizer over a period of time. For the Tc value, Soil Olsen-P ranged from 10 to- 15 ppm P_20_5 whereas it ranged from 50 to 55 ppm $P_2\ 0_5$ for the Ts value (Figure2).

Combination of the above weighed parameters gives a good indication of the scale of soil P availability(Table 3), being either low, medium or high , and suggests one of three P fertilization strategies:

- Intensive fertilization strategy (S1) to achieve an adequate level of P in soil.
- Maintenance strategy(S2) to keep up available soil P at the adequate level.
- Withholding strategy (S3) means no P application over a period of time, unless crop high P requirement justifies P addition. Soil P content should be monitored closely and kept up at adequate level (Ts).

For a given P fertilization strategy and crop requirement, COMIFER suggests using a multiplier coefficient (K) for calculating fertilizer recommendations. For any combination of parameters, the coefficient is confined between 0 and 2.5 (Table 4), values which are applicable in dryland as well as humid or irrigated lands. If the expected crop yield is known in a given area, and crop P removal from soil (E) can be estimated, the P fertilizer recommendation (F) can therefore be computed as follows: $F = K \times E$.

The COMIFER diagnostic technique was tested under the semi-arid and arid climate conditions using data from about 175 field experiments in the region. The results proved to be fairly accurate in these climatic zones and this diagnostic technique of soil available P can be brought into general use. The critical values (Tc) and sufficient values (Ts) were both determined from field experimental data to range from 20 to 25 and 50 to 55 ppm P_20_5 respectively, base on Olsen method.

The results of this study showed a higher multiplying coefficient, as illustrated in table 5, however the P fertilizer recommendation rates are very low because the expected yields under arid environment are also very low.

Conclusion

The survey carried out by IMPHOS in collaboration with National Agricultural Research Centers of the Mediterranean countries highlighted the need for phosphorus as one of the most limiting nutrients to crop production in the region.

The need for P can be ascertained by using the established Olsen soil test (0.5 M $NaHCO_3$) recommended for the calcareous soils of the

Mediterranean area. This test has proven to be a reliable tool for distinguishing between situations of phosphorus deficiency and adequacy in relation to crop requirement.

The study suggested a new simple diagnostic technique to help extension agents of the region design appropriate phosphate fertilization strategies based on soil P content and availability, crop requirement, past fertilization management practices, and expected crop yield within the region.

This approach will help farmer make proper and efficient use of P fertilizer. Indeed, the survey showed that some farmers are using less fertilizer than needed for optimal yield while others are using more fertilizer than crop requires. The extra P added could be more effectively used in other farm fields where P is deficient and needed.

P fertilizer recommendations should be based on scientific results available at the National Agricultural Research Centers. This inevitably leads to enhance crop yields and the economic welfare of the farmer and the economy of the country as a whole. In addition, it establishes the credibility of local communities, and the indispensable role of the fertilizer industry in the economies of local communities, and at the national and regional levels.

** Excerpt from a paper presented by Mr B.AMAR, Agronomist at Imphos, to the «Fourth African Crop Science Conference», Casablanca (Morocco), 11-14*

Table 1: Crop P requirement classes

P Crop Requirement	CROP
Low	S. Wheat, Oat, Corn, Sunflower, Soybean, Sugar cane,
Medium	D. Wheat, Barley, Sugar beet, Rice, Cotton, Carrot, Artichoke, Melon, Onion, Cucumber
High	Leguminous plant, tomato, potato, tobacco, lettuce

Table 2 : Scale of field P fertilization history

P balance (F-E)	Soil P Fixing Capacity		
	<80 ppm	80-185 ppm	>185 ppm
<-15kg P205/ha	Medium	Unfavorable	Unfavorable
-15 Kg P205/ha	Favorable	Medium	Unfavorable
>65 Kg P205/ha	Favorable	Favorable	Medium

Table 3: Scale of soil P availability

Fertilization History	Soil P content (P_2O_5 Olsen)	Crop P requirement		
		Low	Medium	High
Favorable	Ts<T	High	High	High
	Tc<T<Ts	Medium	Medium	Medium
	T<TC	Medium	Medium	Medium
Medium	Ts<T	High	High	Medium
	Tc<T<Ts	Medium	Medium	Medium
	T<Tc	Low	Low	Low
Unfavorable	Ts<T	Medium	Medium	Medium
	Tc<T<Ts	Medium	Low	Low
	T<Tc	Low	Low	Low

Table 4: Crop removal multiplier coefficient (K) to calculate P application rate (F=K x E) (irrigated crops or areas with rainfall above 500 mm)

availability	Strategy	Crop Requirement		
Class		Low	Medium	High
High	S3	0	0	1
Medium	S2	1	1	1.5
Low	S1	1.2	1.5	2.5

Table 5: Crop removal multiplier coefficient (K) to calculate P application rate (F=K x E)

STRATEGY	Crop Requirement In the Arid zones(<300 mm) (expected yield < 1.2 t/ha)			Crop Requirement In the Semi-arid zones (300-500 mm)		
	Low	Medium	High	Low	Medium	High
Intensification (S1)	2.5	3.3	4.2	1.7	2	3
Maintenance (S2)	-	-	-	1	1	1.5

Fig 1: Summary of the approach used for diagnostic technique and phosphate fertilization strategies

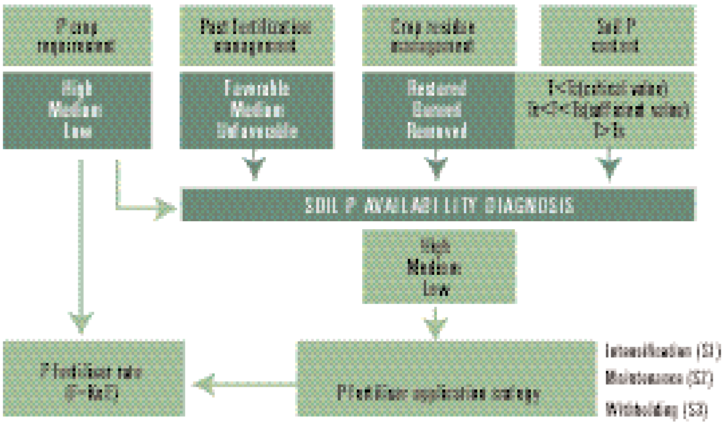
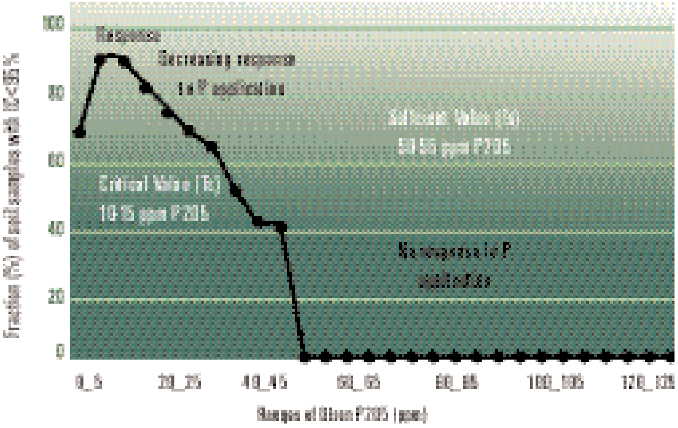


Fig 2: distribution of crop response to P application (IC<95%) by range of 5 ppm Olsen-P205



Crop responses and soil reactions to applied P fertilizes in West European countries.

Combined environmental and economic concerns led many farmers to adopt new fertilizer management practices such as withholding nutrients or applying just the amount removed by the previous crop. Such practices are intended to maximize economic returns to farmers from fertilizer use, promote sustainable agriculture and minimize any adverse effects on the environment. Nevertheless, research data and scientific observations from long-term field experiments do not fully support the assumptions made about these new fertilization practices. In particular, their impact on soil productivity and crop quality remains to be fully assessed.

The World Phosphate Institute (IMPHOS) felt the need for further research on fertilizer management practices in the region and launched in 1989 a survey of the **Utilization of mineral phosphate fertilizers in Western Europe.** The findings from the survey provided a basis for the conduct of an agronomic research network starting from 1991, as well as several other activities in the region. This article presents the main findings.

Survey of Fertilizer Applications and Soil P Status

A questionnaire was mailed to many research and extension organizations in several countries of the region, namely Belgium, Denmark, Finland, Germany, Ireland, the Netherlands, Switzerland and United Kingdom. The result of this survey showed a wide variety of phosphate fertilizer recommendations among countries, ranging from 34 in Denmark to 58 kg P_2O_5 / ha in Germany, and 71 Kg P_2O_5 / ha in Finland, a fact which could not be fully explained by soil scientists. In addition, there appears to be a downward trend in phosphate fertilizer use on some crops, presumably due to new agro-environmental regulations and cash-flow problems of farmers.

As a matter of fact, fertilizer recommendations varied according to the "fertilizer policy" pursued in a particular country or territory within a country, and appear to be closely related to crop requirements of P (high, medium or low).

Soil P status in the countries involved varied as a function of soil and climate conditions, farm management practices, and macroeconomic conjunctures.

It was found that at least ten different soil tests are used in the countries under review (Table 1). Historical and geographical conditions account for the rather wide range of soil analyses used to assess plant-available phosphorus (e.g. Morgan test is used in Ireland while 1% citric acid test is still used for forest soils in south of Belgium). Consequently, the norms used for soil classification according to phosphate fertility levels (deficient, adequate, or excessive) cannot be indistinguishably applied to soils in all countries, sometimes not even to all soils within the same country.

Table 1. Routine soil P tests in some countries of western Europe

METHOD	COUNTRY
Olsen (available P)	Denmark(after 1986)
Na bicarbonate 0.5N	England and Wales
Pw (Sissingh method)	Germany and the Netherlands
Pw saturated with CO_2	Switzerland : Changis, liebefeld and Reckenholz
Acetate NH_4 + EDTA(Cottenie)	Belgium and Switzerland
Acid NH_4 acetate , pH 4.65	Finland
Acetic acid	Finland
Morgan's extractant (sodium hydroxide + acetic acid adjusted to pH 4.8)	Ireland
1% Citric acid P AL (EGNER, RIEHM, DOMINGO)	Belgium and Germany
(ammonium lactate and acetic acid)	Belgium, the Netherlands and Germany
P CAL (acetate-lactate of Ca-extraction solution of SCHULLER)	Germany and Belgium

This fact makes it hard to generalize to the rest of countries in the region the conclusions drawn from data collected or observations made in one country.

Based on collected data and field observations, the decision was made to set up a field experimental network to further the objectives outlined in the 7th issue of the IMPHOS Phosphate Newsletter.

This paper presents the main findings in Belgium (Tinlot), Germany (Volkenrode), the Netherlands (Marknesse), and the United Kingdom (Broom's Barn), during the period 1991-96.

Crop Responses to Phosphorus

Four treatments were tested:

- P_0 no phosphorus applied
- P_1 application rate is set equal to the amount of P removed by the previous harvested crop (It is referred to as "maintenance fertilization")
- P_2 is equal to two times P_1
- P_3 equals three times P_1

At Broom's Barn (U.K), the experimental design established in 1965 provided for only three treatments: 0, 50, and 100 kg P_2O_5 / ha.

To all experimental sites, P and K were applied soon after plowing or just before sowing using as nutrient source TSP (46% P_2O_5) and potassium chloride (60% K_2O) respectively. N was applied as NH_4NO_3 (35 % N).

With "maintenance fertilization", relative responses of fertilized crops compared to crops receiving P_0 treatment are presented in Table 2. The effects of P application were more significant in Broom's Barn than other locations mainly because plots receiving 50 kg P205 per hectare accumulated twice or three

Table 2. Relative Yield responses to P1 ("maintenance fertilization") relative to P0 (No P applied)

	1991	1992	1993	1994	1995	1996
	s. beet	oats	w. wheat	s. beet	oats	w. wheat
Broom's Barn	+ 7	0	+ 34	+ 7	+ 6	+ 33
	s. wheat	s. beet	s. barley	potatoes	s. wheat	s. beet
Marknesse	+ 5	0	+ 17	+ 9	+ 12	+ 2
	s. beet	w. wheat	w. barley	s. beet	w. wheat	w. barley
Tinlot	0	0	0	0	+ 4	+ 3
	s. beet	w. wheat	w. barley	s. beet	maize	potatoes
Volkenrode	0	+ 5	0	0	+ 10	+ 4

times the soil-P level of control plots.

In 1994, crop yield responses to applications twice the maintenance rate were significant in the case of sugar beet at Broom's Barn and potatoes at Marknesse. However, the average effect of doubling the maintenance fertilization was only a slight yield increase of 0.5 % compared to single rate.

When all data are pooled by year and site, they give an idea of the distribution of soil P content where and when yield gain or loss has occurred, as outlined in Table 3.

Despite these differences, there was good correlation between the different soil P tests.

➠Soil test responses to applied P fertilizers

With no P applied, the status of soil P should decline with time while maintenance fertilization would keep it up to its initial level.

Changes in the level of plant-available P at the soil surface layer (0-25cm) were measured every year. Data from Broom's Barn and Marknesse are typical values, as illustrated in Table 5.

Table 3. Crop yield responses in relation to routine soil tests for available P content

	> 10 % yield loss was recorded with no P fertilization and a soil P content below ….	>10%yield increase observed due to P fertilization and a soil P in the range of…	No yield response >10% could be observed with higher P application than maintenance rate and a soil P content of…
P-H20 (mg P205/kg)	3	3-17	17
P-Olsen (mg P/l)	20	20-55	55
P-CaCl2 (mg P/kg)	0.2	0.2-1.5	1.5
P-EDTA(mg P/100g)	3	3-6	6
P-CAL (mg P205/kg)	90	90-170	170
P water (mg P205/l)	18	18-40	40

➠The Fate of Applied Phosphorus

The fate of phosphorus from different fertilizer treatments, mainly maintenance fertilization, and how it affects soil P level as inferred from various soil tests, was extensively investigated. As indicated in Table 1, soil P tests differ in several aspects: pretreatment or not of the soil sample by incubation, soil/solution ratios, type of reagent, its ionic strength and pH, the soil/solution shaking time, and soil sample dry processing. It is not surprising to find out that the quantity of phosphorus extracted by these routine tests varies considerably as illustrated in Table 4.

P applications resulted in increasing soil test values, generally in the order of $P_3 > P_2 > P_1 > P_0$. With crop uptake of phosphorus, the total soil P and the plant-available fraction should normally decrease with time. Yet, the results of soil P tests were not conclusive in that respect.

Despite wide differences in cumulative P balances among plots, the changes in the level of plant-available P were rather small, particularly in the control plots. Therefore, routine methods used for the assessment of soil P fertility must be checked for their reliability.

Table 4. Initial value of plant available P (mg P205) determined by various soils P tests.

Soil P	Broom's Barn	Marknesse	Tinlot	Volkenrode
P-Olsen	4.3	3.5	17.5	10.2
P-EDTA	2.5	2.3	20.3	12.2
P-CAL	5.1	11.6	24.3	13.3
P-CaCl2	0.08	0.06	0.79	0.33
P-H20	n.a	n.a	n.a	3.3
Pw	1.3	1.0	7.2	3.5

n.a : not available

The amount of P extracted varied depending on the specific location and reagent.

P-$CaCl_2$ extracted the lowest quantity of P, followed by Pw (P-H_2O), while P-CAL extracted the highest quantity and P-EDTA extracted more than P-Olsen.

➠Sequential fractionation to detect changes in soil P

To assess more accurately the fate of applied P, a sequential fractionation procedure developed at Rothamsted Experimental Station (United Kingdom) was applied to soil samples taken from the experimental sites in 1991 and 1993. The eight-step sequential extraction procedure helped estimate, where appropriate, the level of both inorganic (Pi) and organic (P_0) P in each fraction. This method was extensively described in the 8th and 9th issue of the IMPHOS Phosphate Newsletter.

P extracted by resin and bicarbonate is considered to be most plant available. The extraction with sodium bicarbonate follows that with resin but does not equate directly Olsen P in routine soil analysis.

A decrease in the inorganic P fraction of the preliminary four P extracts occurred mainly in the P_0 plots, except for the brown sandy silt plots in Germany. The resin-P fraction decreased in Broom's Barn and Marknesse by 26% and 44 %, respectively. Except for Tinlot, the increase in resin P, when added to increase in bicarbonate P and 0.1 M NaOH P fractions, accounted for more than 75 % of total increase in all P fractions. Indeed, the most freshly applied P stored in these particular fractions, which can therefore be used as indicator of P distribution in soil.

It must be noted that more than one fraction is involved in the storage of freshly added P and the distribution among these fractions is quite rapid.

The effects of withholding P on the soil P status are not obvious within the six-year timeframe of the experimental network if only routine soil testing methods are used to determine plant-available P. These methods will not show that the soils are being depleted. In fact, readily soluble P removed by crops grown on control(P_0) plots is replenished in part by "fixed" P held to soils(adsorbed P). If this replenishment continues for some years, it could lead to a decline in soil fertility, hence to unsustainable agricultural production.

➠ Phosphorus Movement Down the Soil Profile

Soil type and topography, cultural practices, mechanisms of P transport in forms less susceptible to soil adsorption, and the existence of preferential flow might in some cases cause phosphorus movement down the soil profile or transfer to surface waters. It is very difficult to assess the extent to which these transfers occur.

In soils with high P fixation capacity, the vertical movement of P through the soil profile is considered generally of little importance unless soils are saturated from repeated phosphate applications over many years. However, P accumulation from such repeated applications do not necessary lead to soil saturation as some people tend to believe without having any available support of data.

From the literature review, P transfer from agricultural land, either from catchments, individual fields or both, is estimated to be less than 1 kg of total P per hectare per year, which represents about 1 to 2 % of the phosphoric fertilizer input.

Possible phosphorus downward movement was investigated by INRA-France in 1997-1998 based on data from long-term experiments. The study examined soil types and P fertilization practices under which measurable quantities of soluble P might move down the soil profile and beyond the root zone.

Several soil samples were taken from field trials set up back in 1967 on a clayey-calcareous soil; at Thure, as well as other trials set up more recently (1976) on a clay-loam-calcareous soil at Mer; and loam-clayey soil at Maves and Villexanton.

At the start of field experiments, Olsen-P levels in the above four sites were 57, 137, 91, and 83 ppm, respectively. At each of the four sites, namely Thure, Mer, Maves and Villexanton, three P rates were applied respectively, that is 0, 1.2, 2.2; 0, 1.3, 2.4; 0, 1.4, 2.4; and 0, 1.4, 2.8 times the offtake of the previous crop. To assess P movement down from the soil surface layer, soil samples were taken from the 25-50 cm layer. To avoid soil contamination during sampling, the soil was dug out deeply and sampled at 2-cm intervals and depths from 25 to 50 cm.

All soil sampling work was performed after many years of experimentation have elapsed: 6 years at Maves and Villexanton, 10 years at Mer, and 21 years at Thure. The transfer of P through the soil profile was determined by measuring the increments in plant-available P below the 25 cm depth using several methods: measurement of phosphate anion concentration in soil water, investigation of the kinetics of isotopic exchange between the soil surface and the soil solution, and Olsen and Joret-Hebert methods.

The main conclusions from this study are the following:

- Even repeated phosphate applications for more than 20 years at rates twice the offtake of the previous crop (very unlikely management under farmer's conditions), no measurable downward movement of phosphorus could be detected;
- In the four sites, the effect of various P fertilizer management practices was limited to the 5-6 cm depth below the plow layer;
- On a clay-loam calcareous soil, repeated applications of phosphate fertilizer over 10 years at rates amounting to 2.4 times the offtake of the previous crop, increased phosphate anion concentration in the soil solution at 35 cm depth. However, it was not possible to conclude whether any downward movement of P has occurred.

The above results are in agreement with those obtained at Rothamsted where no measurable P levels in drainage water were observed until the soil content exceeded 60 mg.kg^{-1} of Olsen- P

Conclusions

Over many years, repeated applications of phosphate fertilizer in West European countries resulted in a buildup of P in many types of soil under different cropping systems. The management of these soils in an agronomically and environmentally sound manner must take into account many factors affecting plant growth, yield and crop quality. These factors, among others, are the P requirement of crops, the size and fate of soil P reserve, and the crop quality as a function of soil P status.

P demanding crops such as potatoes respond well to fresh P applications even in soils with rather high P content. This fact contrasts with the general perception that the "P enriched" soils in Western Europe need no more P fertilization.

The efficient use of P fertilizers is obviously a key issue that deserves further and lasting research effort. Meanwhile, data so far available indicate that application of mineral phosphate fertilizer at about 50 kg.ha^{-1} per crop does not have any negative effect on the environment of crop production farms.

Livestock farms where large applications of farmyard manure result usually in high inputs of phosphorus to soil, the use of mineral P needs much more in-depth analysis as negative side effects might occur. However, these particular cases should not be generalized without due consideration to other crop production systems.

Some P fertilization strategies, in particular the practice of withholding P fertilizer based on the results of local routine soil tests, may not be always appropriate. On many soils, the effects of withholding P are not visually evident and the tools currently in use to monitor soil-P fertility are not powerful enough. There is much evidence to show that readily soluble P removed by crop and not replenished by P fertilizer applications is replenished by less soluble P from the different pools of the soil. If this continues for many years, it will result in a decline in soil-P fertility and hence to a non-sustainable agriculture.

** This article is a synthesis of results from several agronomic research projects launched by IMPHOS and led by researchers in Belgium, France, Germany, the Netherlands, United Kingdom, and France. Peer reviewed publications giving more data and in-depth analysis are under preparation by the scientists involved in these research activities.*

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Table 5. Changes in soil P in the soil surface layer at Broom's Barn and Marknesse

	P-Olsen (mg P/l)			P-EDTA (mg P/100g)			P-CAL (mg P205/100g)			Pw (mg P_2O_5/l)		
	P0	P1	P2	P0	P1	P2	P0	P1	P2	P0	P1	P2
Broom's Barn												
90	18.3	41.8	52.5	1.1	3..3	5.2	5.1	11.8	13.8	12.5	30.5	41.5
91	13.2	26.9	38.2	2.4	4.7	5.7	5.5	12.3	15.2	11.5	30.5	40.0
92	16.0	37.4	54.5	2.1	4.3	5.7	4.5	13.3	15.1	11.5	32.5	49.0
93	16.4	40.0	59.5	2.1	4.1	5.5	3.7	9.5	14.2	10.0	28.0	42.7
94	14.7	34.5	49.5	2.2	4.1	5.2	4.7	10.5	13.8	10.8	30.3	45.0
95	18.0	41.0	50.2	1.6	3.9	4.2	4.5	10.4	14.6	12.5	32.8	47.0
96	18.3	38.2	49.9	2.6	5.3	6.0	4.6	10.5	15.3	14.8	34.5	48.5
Marknesse												
90	13.2	13.2	14.3	0.9	1.0	1.0	10.0	11.3	13.2	8.5	9.3	11.0
91	11.6	20.3	26.3	1.6	2.5	2.6	07.7	11.4	13.2	6.6	10.5	11.3
92	11.7	22.7	30.1	1.6	2.3	2.7	09.1	13.9	16.8	6.1	11.5	16.0
93	10.4	17.7	24.6	1.4	3.0	3.9	08.1	12.4	14.4	5.3	9.0	12.0
94	20.0	26.9	31.1	2.2	2.7	3.1	07.5	12.1	14.8	5.3	9.8	14.0
95	17.9	23.5	39.1	1.5	1.9	2.3	08.3	10.5	13.4	5.6	8.3	12.3
96	12.1	18.8	24.5	2.2	2.8	3.1	09.7	13.1	14.1	7.8	12.8	16.0

Promoting more balanced fertilization in sugar beet production systems

Nutrient imbalances compromise crop yield and will lead in time to unsustainable agricultural production. In an effort to put sugar beet production to a more sustainable development path, the Hungarian Research Institute for Sugar Industry (Beta R.I.), the International Potash Institute (IPI), and the World Phosphate Institute (IMPHOS) organized jointly a workshop on the topic: **"Balanced plant nutrition in sugar beet cropping systems for high yield and quality".**

For two days, on September 1-2, 1999, the workshop held in Budapest (Hungary) attracted the interest of more than 100 participants, mainly from Central and Eastern Europe (CEE), and addressed plant nutrition issues, climatic constraints, and the role and the ways by which advisory systems operate in different countries of the region.

Sugar beet yields are rather low in CEE compared to Western Europe (60 t/ha). They range from about 10 t/ha in Bulgaria to 40 t/ha in both the Czech Republic and Slovenia. On the whole, sugar beet yield in the region stands at the average low level of 36 t/ha, which should be significantly increased to withstand pressures from currently open markets and severe competitiveness from other producers.

Imbalanced fertilizer use is one of the major factors contributing to low yields in CEE. The NPK application ratio in Western Europe (1:0.60:1.38) contrasts with the 1998 application ratio in Bulgaria, Romania, and Yugoslavia at 1:0.07:0.00, 1:0.04:0.0.03, 1:0.29:0.30, respectively. In addition, NPK application rates are generally low in these CEE countries, being currently less than 50 kg/ha nutrients in each of Romania and Bulgaria, for example.

In the move towards sustainable growth in sugar beet yields, the workshop advocated clearly enhanced nutrient balances, judging from available research findings and a backlog of data and information. Such evidence must be brought to the attention of producers, extension workers, and decision-making bodies so that action is taken to promote more efficient and balanced use of the mineral fertilizers and make them more available at farm level.

Logistical, financial, and managerial constraints at the farm level were also addressed at a field visit to the "Marcius 21" cooperative at Adony, about 50 km from Budapest. The president of the cooperative considered inaccessible bank credits and unattractive agricultural commodity prices as important impediments to the adoption of best fertilizer management practices.

IMPHOS In- House Seminar on Strategic planning

The World Phosphate Institute (IMPHOS) turned 25 this year! The occasion was celebrated when an in-house seminar was organized in Tunis, on June 10-11, 1999 to critically review past activities and provide the institute with strategic guidance for the future.

Expanded and efficient use of mineral fertilizers for sustained and increased growth in crop production is a main goal of IMPHOS shared also by other fertilizer industry associations and international scientific organizations. Among these, IMPHOS invited the International Fertilizer Industry Association (IFA), the International Potash Institute (IPI), the Potash and Phosphate Institute (PPI), the International Fertilizer Development Center (IFDC), and the Food and Agriculture Organization of the United Nations (FAO) to share views and information, discuss key issues, and consider taking complementary roles and mutually strengthening their positions as important players in agricultural development.

Contributions from Invited Organizations

IFDC President delivered a keynote paper on “The Global Crop Production and Fertilizers Supply Requirements to 2020: Challenges and opportunities for the fertilizer industry”. He outlined future challenges of increasing world food needs, and reducing poverty and protecting the environment. He addressed a wide range of subjects relating to agricultural technology development, fertilizer production challenges, and policy-relevant aspects of agriculture, fertilizer industry, and the environment.

The fertilizer industry organizations (IFA, IPI, and PPI) presented their main accomplishment and their future poles of activities and international cooperation. On the whole, balanced nutrients supply to crops, efficient use of fertilizers, and promotion of environmentally friendly and intensive agriculture deserved from the fertilizer industry particular attention and firm commitment. It was fully realized that the issues to be addressed require long lasting efforts and sustained financial support, that only enhanced cooperation can help stakeholders undertake key actions, develop complementary activities and pool available resources for the mutual benefit of all partners.

Using FAO comprehensive database comprised of diverse and relevant data which go back to at least 50 years, the FAO representative discussed current and future fertilizer and food requirements. She addressed in her paper the need for increased food production to ensure the food security of steadily growing populations in developing countries, and stressed the use of sound fertilizer management strategies based on scientific knowledge and developed technologies.

IMPHOS Activities in retrospect

Prior to the presentation of the worldwide activities conducted by IMPHOS over the past 25 years, the chair of the Advisory Scientific Committee of the institute outlined the linkage between IMPHOS and the international scientific community, pointed to the main research themes addressed by the institute, reflected on the prospects, as apparent in its mandate.

Papers from IMPHOS secretariat provided detailed information on IMPHOS accomplishments since its foundation in 1973. The papers presented IMPHOS work by geographic area: in sub-Saharan Africa, Asia, Western Europe, North Africa/west Asia, and IMPHOS activities to promote environmentally sustainable phosphate fertilizer use and its role in information retrieval and dissemination.

By critically reviewing past work, results so far achieved, shortcomings, the audience had an opportunity to engage in extensive discussion with the view of building on past accomplishments to ensure more successful work in the future.

Selection of research topics and balanced funding among regions based on the region’s relative imtance in agricultural production and its share in fertilizer use were also addressed.

The seminar stressed issues that need to be further developed and activities to strengthen in the near future. These were taken into account when the seminar discussed prospects for future activities.

Residual Soil Phosphorus and its Implications for Fertilizer Use in the Mediterranean Zone

➟ **John Ryan*: *Natural Resources Management Program, ICARDA, P. O. Box 5466, Aleppo, Syria***

Of the major elements that crops depend on from the soil for growth and development, phosphorus (P) is the most complex. The task of unravelling the chemistry of P in soils and its reactions with added fertilizer has baffled scientists for well over a century. The advent of the age of chemical fertilizers, stemming from the work of Lawes and Gilbert with superphosphate at Rothamsted in the mid 18th century, gave rise to the first attempts to elucidate the intractable nature of soil P. While it was possible then to make some measure or index of solubility, with an assumed relationship with the plant's need for P, precise description of the P soil /plant dynamics were practically insurmountable, and were to remain elusive for decades until the advent and use of radioisotopes in soil-plant-relations research.

Nevertheless, a number of practical implications were known: most, if not all, soils were deficient in P, causing low crop yields; when they were fertilized with P, dramatic yield increases were obtained. In essence, the problem with soil P, as far as crops are concerned, is its low concentration in the soil solution and a limited capacity of most soils to replenish or continuously supply P for active root uptake. Even when soluble fertilizers such as superphosphate are added, much of added P is fixed in the soil in chemically unavailable forms. As a result, the effect of normal applications to severely P-deficient soils rarely lasted more than one year – it had to be applied on a yearly basis for sustained benefit. Measurements of the amount of P removed by crops, either indirect or by isotopic techniques, showed that only 10 – 20 % of the P fertilizer was taken up by the crop, and most of that in the year of application.

At the global level, decisions about fertilizer use at the government and public level must consider the inherent fertility of the soils (which is dictated by many environmental factors), the type of farming or land use, farmers socio-economic circumstances, and by the current extent of fertilizer use. At the broad-scale level, low soil fertility – primarily P – is now seen as the major factor limiting agricultural output in Africa, even more important than lack of water. This awareness has simulated the World Bank, in coordination with the International Fertilizer Development Center (IFDC), to launch a Soil Fertility Initiative or nutrient re-capitalization program for Africa in the hope of halting "soil nutrient mining". With substantially increased use of fertilizer – and thus enhanced soil nutrient levels–lay the foundation for agricultural development. Phosphorus fertilizer is central to this effort.

While many of the generalizations about P in soils in other areas of the world apply to the soils of the Middle East, one must recognize the unique circumstances that pertain to this region. Indeed, as most soils of this semi-arid zone are calcareous, the problem of low native or inherent P availability is exacerbated due to the adverse effects of calcium carbonate on adsorption, precipitation and P equilibria (1 and 2). It was shown that the influence of $CaCO_3$ on P chemistry was modified by other soil constituents such as iron oxides(3). Laboratory studies showed that the residual or longer-term effect of fertilizer P was also influenced by soil properties – in essence, soil types (2 bis). Such advances in our understanding of P behavior in the soil help to explain observations on P fertilization in the field.

In the early days of commercial fertilization in the Middle East, about three decades ago, little fertilizer was used – and that was applied to soils that were extremely deficient soils – and so the issue of a carryover effect was not relevant. But that situation has now changed, and it calls for a corresponding change in our perceptions. Fertilizer use has increased steadily in most countries of the region, consumption is now 10 – 20 times what it was then, but is still low by world standards. Fertilizer P use is now routine practice – indeed is indispensable – in irrigated agriculture.

As a result of extensive field trials in many countries of the region (3,4), it is now widely used in rainfed agriculture as well, mainly in the more favorable areas with rainfall above 300 – 350 mm per year. Indeed, field trials from Morocco have shown that in the drier part of the rainfall spectrum ($<$ 300 mm), yields of barley, which is more drought-tolerant and more adapted to drier areas, could be considerably increased by P fertilizer use. A similar situation obtains in dryland areas of Syria (See Mazid, the 10th issue of this Newsletter). Notwithstanding the increased adoption of fertilizer use in WANA, a large majority of farmers – if not most – still under-fertilize, or use none at all.

The need for P can be ascertained by soil testing. The established test for calcareous soils of the Mediterranean area is that of Olsen (using 0.5 M NaHCO3) which has proven to be reliable in distinguishing deficiency and adequacy in the soil in relation to crop needs. According to this test, critical or threshold levels are about 6 ppm (or mg /kg soil) for rainfed crops(3,5) and about 12 – 15 ppm for irrigated crops according to criteria developed elsewhere. The amounts of fertilizer to be applied is directly proportional to the degree of deficiency, with minimal or no fertilizer used when test values are well into the sufficiency range.

Rational use of fertilizer is based on having an appropriate test, i.e., correlation with nutrient uptake, and having a good relationship between the amount of fertilizer applied in the field and crop yields, i.e., calibration. While logistically, such work is easier on an agricultural experiment station, many stations are characterized by high levels of available P due to buildup of reserves as a result of indiscriminate fertilization, especially for experimental trials where P is not a variable and where liberal amount are routinely applied to ensure adequacy. Thus, recommendations on P use based on experimental station research may distort conditions which obtain in farmer's fields. While some farmers over-fertilize with respect to P, often the result of applying compound fertilizers with fixed nutrient ratios, they are the exception.

Since its inception in 1977, ICARDA has been heavily involved in P research in partnership with the national agricultural research program in the West Asia - North Africa region. The changing situation with respect to soil P prompted studies that evaluated residual P in relation to annually applied P, and assessed how long such residues persist in the soil. The study(6) at three experiment stations in northern Syria showed that even though heavy applications of P could raise available P levels and eliminate a response from added P on an annual

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*Member of the Imphos Scientific Advisory Commitee basis, the effect of heavy dressings disappeared after a few years, to an extent depending on the amount applied. In shallower on-farm soils with lower initial P applications, the residual effect would probably be less. This reflects the well documented behavior of P reactions in soil, i.e., the initial reaction products are relatively plant – available but they are metastable and, as such, they slowly become less soluble; after equilibrium is established, the added P will be as insoluble as the original compounds in soil.

ICARDA has adapted a strategy with respect to P fertilizer use, which could provide a guiding principle at farm level and at the county or regional levels. It has used soil testing to identify fields where soil P is deficient and where fertilizer is needed; it has reduced application where the soil P levels were well above adequate, but monitored such fields carefully. It makes economic sense to invest financial resources where the returns on each unit of investment are maximized. As fertilizer-use efficiency is maximized in the year of application, ICARDA practices annual fertilization based on soil tests. While such tests may not be possible for all farmers, general guidelines can be established by sampling representative farms with an area where farm practices and cropping systems and soil types are relatively similar.

In conclusion, given the inherent tendency of all soils to be deficient in plant available P or to eventually become so, even after being fertilized, there is no substitute for regular use of phosphatic fertilizers as a basis for improved and sustained crop production. The need can be established through soil tests in coordination with recommendations for application rates based on calibrated field trials. Where the soil is severely P deficient, substantial amounts of fertilizer are needed to "buildup" available P reserves to acceptable levels; later smaller "maintenance" application rates are needed. Efficient use of fertilizer has to be based on science. This inevitably leads to enhanced-crop yields and the economic welfare of the farmer and the economy of the country as a whole. In addition, it establishes the credibility and the indispensable role of the fertilizer industry in the economic welfare of the farmer and the economy of the country as a whole. In addition, it establishes the credibility and the indispensable role of the fertilizer industry in the economies of local communities and at the national and regional levels as well.

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Chemical Characteristics of the Most Commonly Used Phosphorus Sources for Fertigation

Fertilizer	Formula	Content %			EC*	pH (**)	Solubility	Advantages	Disvantanges
		N	P_2O_5	K_2O	(ms/cm)		at 15°c (g/l)		
Monoammonium Phosphate (MAP)	$NH_4 H_2 PO_4$	12	60	0	1.16	4.7 (1)	230	Soil acidification Reasonably priced	Chemical reaction with Ca and Mg to form insoluble products
Phosphoric acid (PA)	H_3PO_4	0	54	0	2.0	2.2 (1)	-	Primarly used for pH control and as P source	Hazardous Chemical to work with
Urea phosphate (UP)	$CO(NH_2)_2 H_3PO_4$	17	44	0	1.3	2.7 (0.5)	120	Suitable for acidifying water and soil and keep drip system free from	not used where soil acidification is not desired clogging
Monopotassium phosphate (MKP)	$KH_2 PO_4$	0	52	34	0.7	4.5 (0.1)	330	Suitable for plants with high K and low N requirements	Expensive source of P compared to MAP

** pH at number of g/l of distilled water

* Electrical conductivity at 1 g/l of distilled water

Source : B. A'Bear, 1999 ; P sources for fertigation in Ryan J. (ed) Proceedings of the workshop : Plant Nutrient Management under pressurized irrigation systems in the mediterranean region. IMPHOS, JPMC, NCARTT and ICARDA (in press)

Fertilizer Subsidy Policy in India

Agriculture is a very vital sector of India's economy. It accounts for 32 per cent of the Gross Domestic Product, provides employment to 67 per cent of the workforce and earns 27 per cent of India's foreign exchange. Growth of agriculture is an indicator of the health of the overall economy, but its role in making India "self-sufficient" in foodgrain production is even more important.

India's agriculture consists of about 90 million cultivating farming families widely spread over different parts of the country. And of those, 75 per cent are small and marginal farmers that land holding less than 2 hectares. They are also called "subsistence" farmers because they are producing food mainly for self-consumption. Consequently, the policy with regard to fertilizers must ensure the availability of this critical input in 'reasonable' quantities in all parts of the country.

Fertilizers – Key input in Indian Agriculture and Food Security

Fertilizer is an essential agricultural input for increasing the productivity of foodgrain and other crops. This is because mineral fertilizers are a major source of plant nutrients needed to supply the requirement of intensive agriculture based on widespread use of high yielding varieties(HYVs). Plant nutrients are neither adequately available from soil reserves, nor can they be procured in sufficient amounts from alternative sources like organic manure, crop residues or bio-fertilizers. Therefore, fertilizer use must necessarily be increased to supply the nutrients for increasing foodgrain production needed to feed the growing population at acceptable nutritional levels. It is primarily because of this linkage with agriculture and the overriding need to maintain self-sufficiency in foodgrain production which fertilizers assume special significance. Unlike any other commodity, any reduction in fertilizer use can seriously jeopardize the goal of food security.

Being a strategic input in agriculture, a certain measure of self-sufficiency in the availability of fertilizer is absolutely necessary. This paper argues that that goal cannot be furthered by strict reliance on market mechanisms. In a free market system, the market forces by nature can lead to fluctuating pattern of fertilizer use. A free market system is bound to lead, irrespective of the source of supply whether domestic or otherwise, to high prices that the farmers cannot afford. Considering the dangers in adopting market based policies, the Government consciously preferred in the past to exercise controls through positive interventionist policies. In doing so, the Government of India maintained the selling price of fertilizers at affordable levels on the one hand, and on the other, facilitated growth of the domestic industry by assuring reasonable return on investment.

Retention Pricing Scheme

The Government phased in from late 1977 to early 1979, a pricing policy commonly known as the Retention Pricing Scheme (RPS). Under the RPS, a fair ex-factory price commonly known as the retention price, is fixed for the product manufactured by a unit based on prescribed efficiency norms with regard to capacity utilization and consumption of raw materials and utilities. The pricing mechanism allows for a post-tax return of 12 per cent on networth. The excess of the retention price over the net realization from selling at the controlled price to the farmer is reimbursed to the manufacturer as subsidy. The costs of transporting the material from the factory to the consumption point is also reimbursed to the producer as equated freight computed on a normative basis.

In this arrangement, the manufacturer is fully covered for his production and distribution cost as determined on a normative basis, whereas the farmer continues to pay what he can afford. The balance is paid by the Government of India as subsidy. In short, the system serves two objectives: increasing consumption of fertilizer on the one hand and domestic production on the other.

The RPS indeed performed a neat balancing act and provided a conducive environment for the growth and sustained health of the Indian fertilizer industry. This may be gauged from the fact that in 1991-1992, the Indian industry was contributing about 91 per cent of the nitrogen consumption and 82 per cent of the phosphate consumption.

Growth in Fertilizer Subsidy

The fertilizer subsidy, under the RPS, increased from Rs. 5.05 billion in 1980-81 to about Rs. 44 billion in 1990-91. This was primarily on account of four factors: (I) increase in the level of production and consumption (ii) bulk of increase in production came from new units commissioned at a much higher cost (iii) steep increase in the administered prices of feedstock, power utilities and services supplied to the fertilizer industry and (iv) practically no increase in the selling price of fertilizers to the farmers during the decade of the1980's.

All through the 1980's and 1990's, the increasing oil/gas prices, power and railway freight tariffs…etc. have been responsible for the bulk increase in the subsidy.

Decontrol of P and K Fertilizers

In a bid to curb the rising fertilizer subsidy, the Government decided to take various strategies / measures to reduce fertilizer subsidy or eliminate it completely. With effect from August 1992, the Government decided to decontrol the phosphatic and potassic fertilizers. Simultaneously, however, the controlled selling price of urea was reduced by 10 per cent even as it continued to be under the RPS. Ammonium sulfate (AS), Calcium ammonium nitrate(CAN) and ammonium chloride(ACl), earlier decontrolled in 1991, were brought back under control and covered by the RPS.

It is necessary to analyze the subsidy withdrawal implications for fertilizer consumption and the industry. Clearly, the approach to subsidy reduction has been lopsided and various measures implemented so far have not taken full consideration of the factors that contributed to the increase in the quantum of subsidy. In addition, the policy changes have led to serious adverse effect on production and consumption, not to mention the increasing imbalances in the N.P.K. use ratio

Adverse Effect on P and K Consumption

The consumption of phosphate declined from 3.32 million tons in 1991/92 to 2.84million tons 1992/93 and further to 2.67 million tons in 1993/94. During 1994/95, it recovered to 2.94 million tons which was still lower by about a substantial 380 thousand tons compared to 1991/92.

The consumption of K declined sharply from 1.36 million tons in 1991/92 to 0.88 million tons in 1992/93 and recovered thereafter to 0.91 million tons in 1993/94 and further to 1.06 million tons in 1994/95.

The trend of increasing N consumption and stagnating P and K consumption at lower level continued through 1996/97 reaching respectively the levels of 10.3, 2.98 and 1.03 million tons nutrient.

➠ Increasing Imbalance in N, P, K Use Ratio

The sustained increase in the consumption of N on the one hand and decline in the use of P and K on the other has resulted in deterioration in the N, P and K use ratio. Already in 1991-92, at the N:P:K ratio at 5.9:2.4:1was far from the ideal of 4:2:1. During 1993-94, the imbalance had aggravated to 9.7:2.9:1. During 1994-95, the ratio slightly improved to 8.9:2.8:1, but by 1996-97, it deteriorated to 10:2.89:1. India, thus, continued to remain way behind the N:P:K ratio of 1991-92.

➠ Negative Impact on Production

The situation on the production front is far from encouraging. The installed capacity of nitrogen at 10.52 million tons during 1997-98 was only about 2.2 million tons higher than it was in 1991-92. The increase has come about mainly from implementation of projects that were planned in the 1980's and some expansion projects in public and cooperative sectors, thus clearly implying that no fresh investment was undertaken by the private sector in the 1990's.

In the phosphate segment, even as the installed capacity increased marginally since 1991-92 from 2.81 million tons to 3.14 million tons, the period has not witnessed any significant investment activity specially in the DAP and other complex phosphatic fertilizers.

Phosphate production declined sharply from 2.56 million tons in 1991-92 to 2.32 million tons in 1992/93. Continuing the declining trend, it reached an all time low in recent years of 1.87 million tons in 1993/94. During 1994/95, it recovered to 2.56 million tons, the same as in 1991/92. Even during 1996/97, the production of P stagnated at around 2.58 million tons.

Investment in setting–up of phosphatic fertilizer plants in the country is no longer attractive.

➠ Suggested package for Phosphates and Potash

In the phosphatic sector, despite the decontrol, the core issue of maintaining the selling prices to the farmers at reasonable level on the one hand and ensuring the viability of the manufacturers on the other remains very relevant. In this context, recent substantial increase in the concession price of indigenous DAP to Rs. 4400 per ton with effect from. 1st April, 1998 and proportionately on other complex fertilizers, is a major step forward in maintaining prices within affordable limits of the farmers. However, it is equally necessary to fix the consumer price at a realistic basis, taking into account the reasonable cost of production / import and distribution so that supplies are viable. Alternatively, the consumer price should be left free to be decided by the industry after taking into account the level of concession.

➠ Increase in Cost of Imported Raw Material / Intermediates to be compensated through Increase in Ad-hoc Concession / Selling Price

Being entirely dependent on import of raw materials and intermediates, which alone account for about 80-85% of the total cost of DAP, the domestic industry is particularly vulnerable to increase in the cost and freight(C and F) of landed imported raw and intermediates materials, but even more vulnerable to the depreciation of the Rupee. Any increase in the reasonable cost of production and distribution on account of these factors, which are beyond the control of the industry, should either be allowed by way of corresponding increase in the amount of concession price or increase in the selling prices to the farmers. This is necessary to ensure that supplies are not disrupted on account of production becoming unviable in the face of rising cost.

Conclusion

Fertilizers provide the essential plant nutrients for crops to support the required increase in food grains and other agricultural products. Increasing fertilizer use is thus of vital importance to achieve food security and make Indian agriculture self-reliant. While implementing appropriate strategy and measures to control growth in subsidy including measures to maintain administered prices of various feedstock to the fertilizer industry at their existing levels, India should not loose sight of this fundamental objective.

Source : Excerpt from a paper presented by Mr. Pratap Narayan representing the Fertiliser Association of India (FAI) at the 5th Arab Fertiliser association(AFA), International Annual Conference, Cairo, February 1999.

Phosphate Production and Consumption in China : Current Situation and Prospects*

I. PRODUCTION :

China capacity for fertilizer production was about 36 million metric tons P_2O_5 in late 1997, as evident from the numerous fertilizer manufacturing plants: more than 1,200 plants for straight fertilizer alone, including 470 straight phosphate fertilizer plants. Most of them are small in capacity.

Phosphate fertilizer production in China has increased steadily at the average annual rate of 5 % over the past five years. The main products consisted of DAP/MAP, SSP, TSP, Fused Calcium Magnesium Phosphate(FCMP), and Nitrophosphates(NP). Production during the past six years is shown in Table 1 :

For four successive years, phosphate production in China has been ranked as one of the highest in the world, second only to the USA. But the products are of low grade, consisting mainly of SSP and NP. Production capacity of high concentrated phosphate fertilizer is yet to be expanded in the near future.

II. CONSUMPTION :

Fertilizer consumption in China has increased dramatically in recent years, with an average growth rate of 7%. Since available fertilizer products in China are mainly of low grade and single nutrient, application rates are generally low, except for rice. With quick development of the country's economy, farmers are switching their nutrient sources, from straight to highly concentrated compound fertilizers.

China is feeding 22% of world population with only 7% of the world arable lands. The population is expected to increase to about 1.35 billion in 2005 and 1.4 billion in 2010; the corresponding demand for food would rise to about 0.54 and 0.56 billion tons, respectively.

While the arable area is not expected to increase; the demand for fertilizer is projected to stand at the figures of 42 to 45 MT in 2005 and 47 to 50 MT in 2010. Given the current capacity for fertilizer production, the shortfall in supply over demand is expected to grow wider in the future, leading to even more imports as evident from the trend shown in Table 2 :

Table 1: Production of Phosphate Fertilizer, Product-wise

(Million Tons P_2O_5)

Year	DAP/MAP	SSP	FCMP	Others	Total P205
1992	0.225	3.249	0.936	0.140	4.55
1993	0.242	3.078	0.704	0.146	4.17
1994	0.444	3.417	0.879	0.230	4.97
1995	0.551	3.914	1.205	0.510	6.18
1996	0.752	3.849	0.805	0.344	5.75
1997	0.950	4.207	0.912	0.331	6.40

Table 2: Imports of Phosphatic Fertilizers

(Million Tons P_2O_5)

Year	1992	1993	1994	1995	1996	1997
Import	2,070	1,210	2,110	3,170	2,530	2,580

III. Prospects :

With China pending admission to World Trade Organization(WTO), international competition will force many small –sized plants with high energy consumption and serious pollution problems to shut down. The fertilizer industry in China will then witness dramatic changes, particularly during the period 2000-2010.

The problem of the moment is where to find the capital needed for revamping middle-size fertilizer plants. Additional investments can save energy consumption and increase fertilizer production remarkably in most middle-size plants. Revamping is regarded as the best road to the development of fertilizer production in China in the future, because of its low investment cost and quick return.

**Excerpt from an article by SUN Fengge and LI Zhijian, of China National Chemical Planning Institute, presented at the 67th IFA Annual Conference in Manila, The Philippines (17-20 May 1999).*

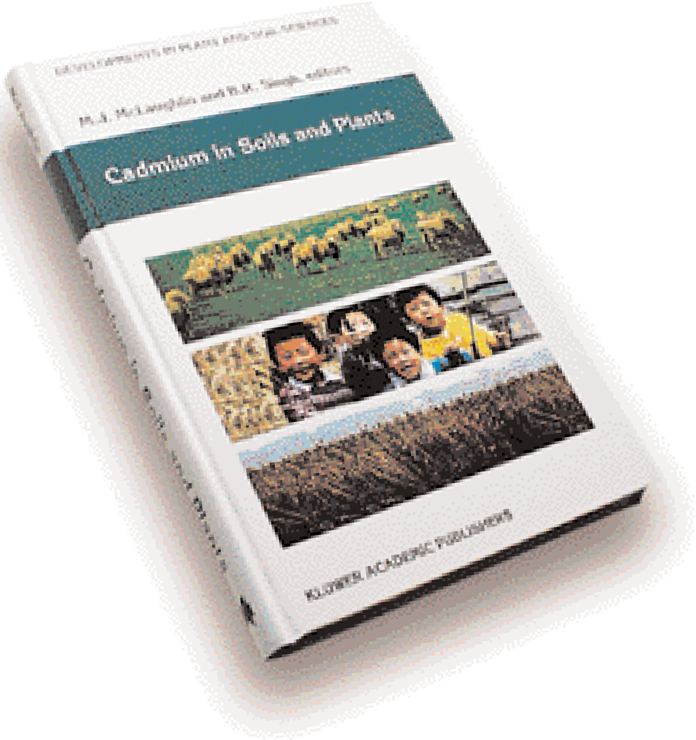
NEW PUBLICATION

“Cadmium in Soils and Plants” is the title of the proceedings of the symposium held at the University of California, Berkeley, in June 1997, an event that is part of the Fourth International Conference on the Biogeochemistry of Trace Elements.

Sponsored partly by IMPHOS, the symposium represented a state-of-the-art review of cadmium and highlighted gaps in current knowledge and understanding of the subject. The book issued from the symposium will become a major reference for those involved in the study and management of cadmium in soils and the food chain.

Chapters of the book:

- The environmental chemistry of cadmium
- Chemistry of cadmium in soil solution
- Solid phase cadmium and the reaction of aqueous cadmium with solid surfaces
- Anthropogenic additions of cadmium to soils
- Mechanism of cadmium uptake, translocations and deposition in plant
- Management factors which influence cadmium concentrations in crops
- Adverse effects of cadmium on soil micro flora and fauna
- Soil cadmium as threat to human health
- Cadmium in soils and plant



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Comming events *:

Fore more information about the upcoming fertilizer related events, please contact directly the following organizers :

26 – 29 March 2000 :
Denver, Colorado, USA
14th Industrial Minerals International Congress
Contact : IMIL, Park house, park Terrace, Worcester Park, Surrey, KT4 7HY, UK
Fax : + 44 (0) 181 337 8943

3 – 7 April 2000 :
8th World Filtration Congress
Brighton, England
Contact : Amy Richardson, WFC8 Conference Secretariat
Elsevier Science, The Boulevard
Langford lane, Kidlington
Oxford OX5 1 GB , UK
Tel : + 44 1865 843 643
Fax : + 44 1865 843 958
Email : a.richardson@elsevier.co.uk

08 – 13 April 2000 :
Plant Nutrition for the Next Millennium
Xth IAOPN International Colloqium.
International Association for the Optimization of Plant Nutrition
Cairo, Egypt
Fax : + 202 361 0850

22 – 25 May 2000 :
68th IFA Annual Conference
Oslo, Norway (open to IFA members only)
E-mail : ifa@fertilizer.org
Web : www.fertilizer.org

25 – 29 June 2000 :
8th International Conference on Flow Analysis
Warsaw, Poland
For further details contact : Prof. Marek Trojanowicz, conference Chairman, Department of chemistry, University of Warsaw, Pasteura 1, 02-093 Warsaw, Poland.
Phone / Fax : + 48 22 822 35 32
Email : trojan@chem.uw.edu.pl
Web : http : \\www.congress.pbp.com.pl/flow/

27 – 29 June 2000 :
13th IFA International Annual Technical Conference
Arab Fertilizer Association – Tunisia
Fax : + 202 417 3721
E-mail : info@afa.com.eg

17 – 21 July 2000 :
IFDC International Meeting Malaysia
Direct application of phosphate rock and related technology
International Fertilizer Development Center
Fax : + 1 256 381 7408
E-mail : hrd@ifdc.org
Web : www.ifdc.org

17 – 22 August 2000 :
Crop Science 2000 – Meeting Future Human Needs – 3rd International Crop Science Congress
CCH Congress Centrum, hamburg, Germany
Fax : + 49 40 3569 2269
Email : crp-science@cch.de
Web : http:\\www.cch.de/CROPSCIENCE/

3 – 8 September 2000 :
EUROANALYSIS XI
Lisboa, Portugal
Contact : German Chemical Society
Congress Department, P.O. BOX 900440 Frankfurt, Germany
Tel : + 49 69 7917 365
Fax : + 49 69 7917 475
Email : tg@gdch.de

10 – 14 September 2000 :
114th AOAC International Annual Meeting and Exposition
Philadelphia, Pennsylvania, USA
Contact : Carolyn Dell, Meetings and Education Department ,
AOAC INTERNATIONAL
481 North Frederick Ave, Suite 500, gaithersburg, MD 20877, USA
Tel : + 1 301 9247077
Email : meetings@aoac.org
Additional Information :
http : \\ www.aoac.org

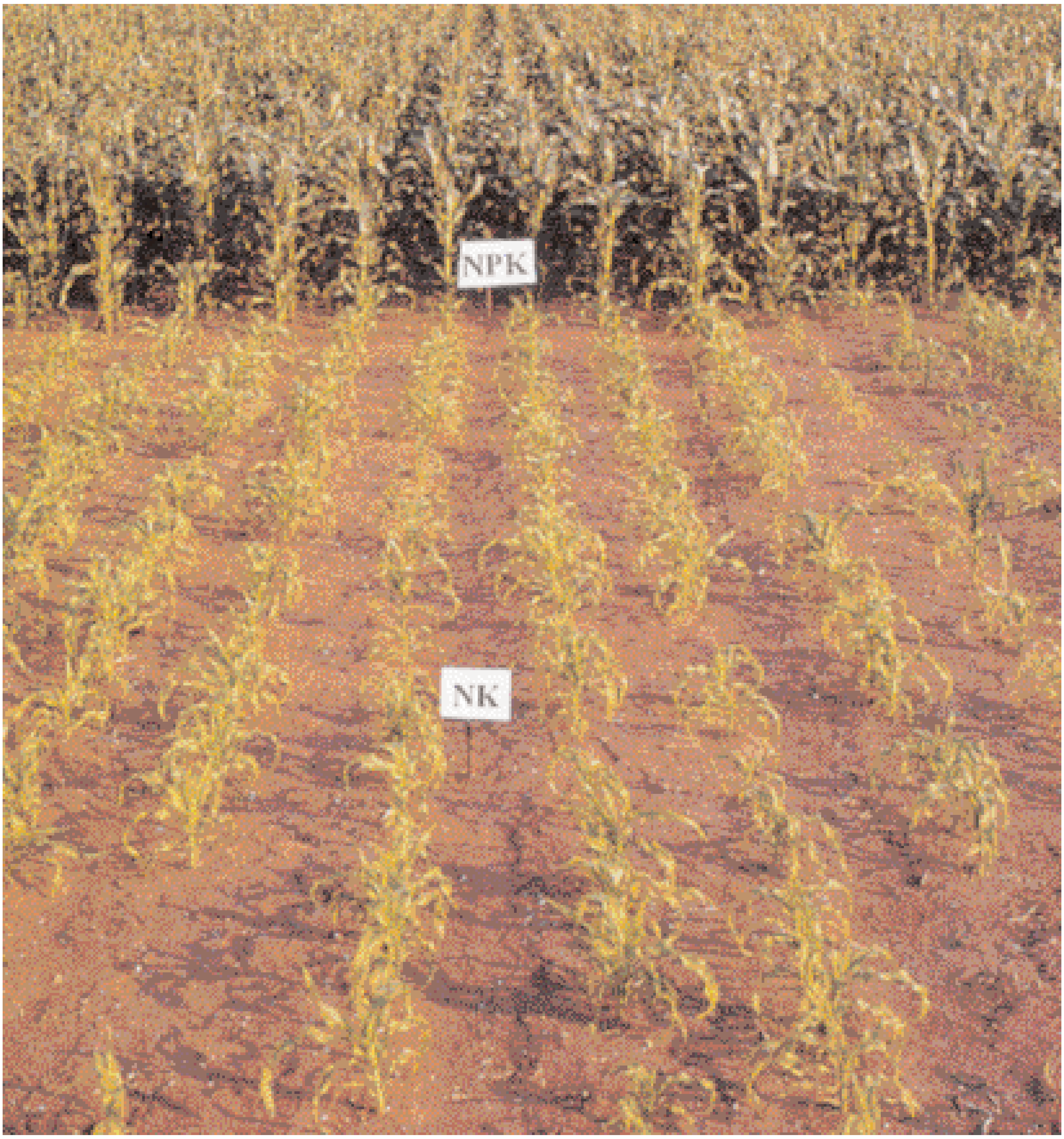
1 – 4 October 2000 :
IFA Technical Conference
New Orleans, USA (Open to IFA Members only)
E-mail : ifa@fertilizer.org
Web : www.fertilizer.org

4 – 7 December 2000 :
IFA Regional Conference for Asia and the Pacific
Yokohama, Japan (Open to IFA Members only)
Email : ifa@fertilizer.org

28 July – 3 Aug. 2001 :
14th International Plant Nutrition Colloquium
Hanover Germany
Fax : 49 511 762 3611
Email : ipnc@mbox.uni-hannover.de

3 – 9 Aug. 2001 :
12th CIEC World Fertilizer Congress
Beijing, China, International Scientific Centre of Fertilizers (CIEC)
Contact Prof. Chen, Institute of Applied Ecology,
Shenyang, China
Fax : + 86 24 238 43 313
Email : CIEC2001@pb.fal.de

*If you know of any other conferences or events related to plant nutrition/fertilizer us then please send them to us.



Role of phosphorus in crop production