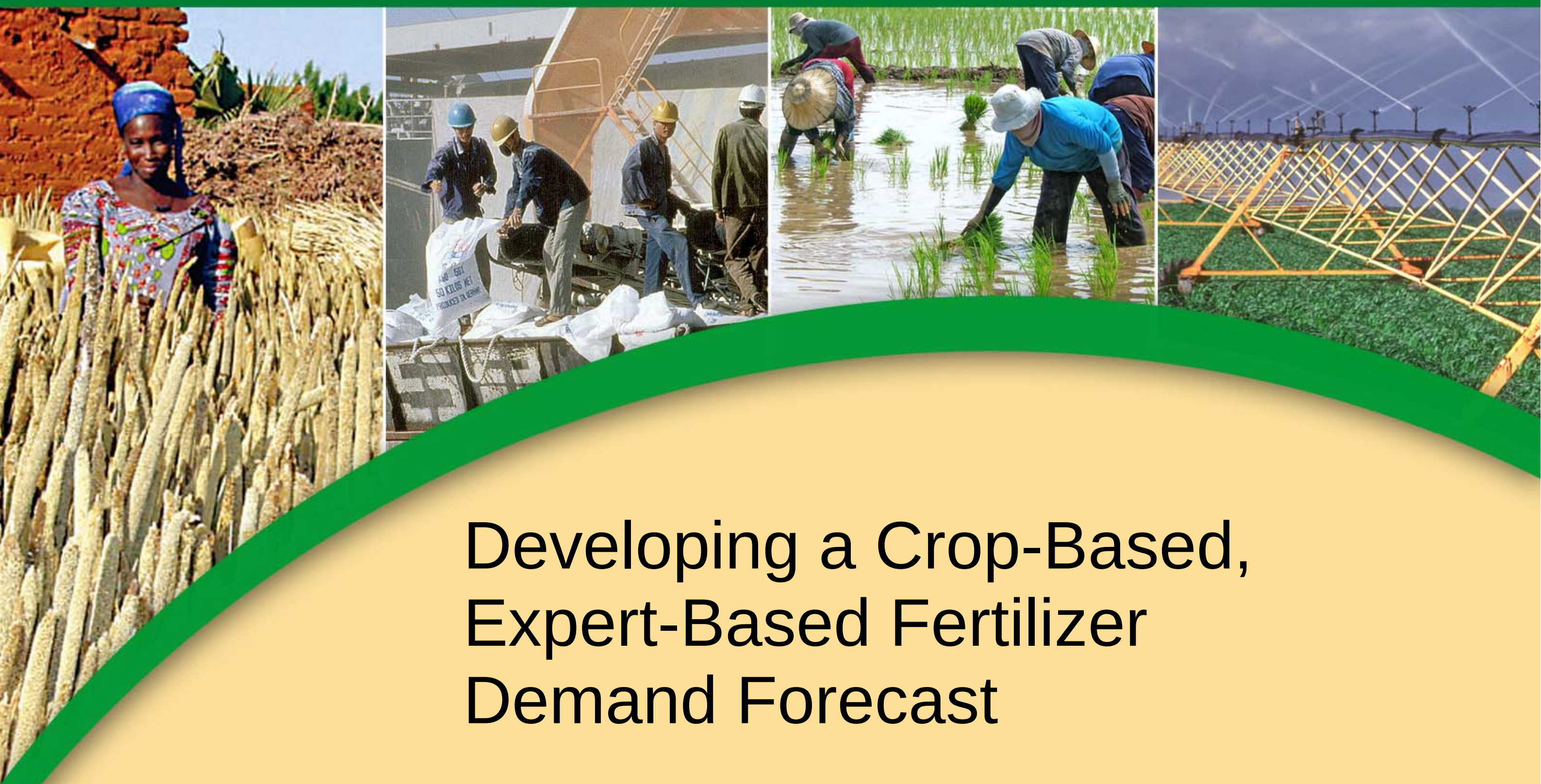
AgCom/07/23
February 2007



Developing a Crop-Based, Expert-Based Fertilizer Demand Forecast

Overview and Methodology

International Fertilizer Industry Association (IFA) - 28, rue Marbeuf - 75008 Paris - France
Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

Copyright © 2007 International Fertilizer Industry Association – All Rights Reserved

General Objective

Forecasts of fertilizer consumption are an extremely important and needed tool. The information from these forecasts is useful to a variety of individuals and organizations such as agricultural researchers, fertilizer marketing managers, government agencies, public policy makers, and international agencies. For the fertilizer industry specifically, these forecasts are essential in order to efficiently develop the production capacity and infrastructure required to meet the needs of farmers around the world.

While fertilizer forecasts are a useful tool, they must also be reasonably accurate. It can be argued that inaccurate forecasts have been a contributing factor for the significant amount of volatility that has existed in the fertilizer industry over the past three decades. For example, extremely high forecasts of fertilizer demand in the 1980s were used to justify a rapid increase in fertilizer production capacity which, in turn, led to oversupply and unstable markets.

Box 1: What is a good forecast?

A good forecast must be as realistic as possible. If forecasts are too optimistic, they can lead to over-investments in fertilizer production capacities, over-supply and declining fertilizer prices. On the contrary, if forecasts are too pessimistic, they can discourage investments in fertilizer capacities and, as a result, they might endanger world food security.

To be accurate, forecasts must be “independent” from commercial pressures, but also from the governmental objectives and fertilizer recommendations. Projections by the forecasters on the planted area, the percent area fertilized and the average fertilizer application rates require a critical analysis and can be significantly different from governmental recommendations for fertilization practices and from governmental objectives for agricultural production. A good forecast is the “most likely scenario”. It is very often much more conservative than governmental targets, which tend to be over-optimistic, in particular in many developing countries. In fact, governmental targets are often established considering a best case scenario, which rarely occurs for a number of reasons, such as unfavourable weather conditions or disease outbreaks.

Good forecasts are also useful tools for developing appropriate policies (e.g. on fertilizer subsidies) and regulations (e.g. guidelines on fertilizer management practices). Similarly to investments in fertilizer capacities, it is critical that these decisions be taken based on accurate information.

Currently, there are a number of organizations and individuals that provide fertilizer consumption forecasts. However, most of these forecasts provide data only on an aggregate basis, often based on a trend analysis. They do not give fertilizer projections on a crop-specific basis and/or are not done on a consistent basis. Developing a crop-based forecast generally gives much more reliable results as it addresses the consumption pattern more precisely.

There are basically two ways of implementing a crop-based forecast:

- *Using an econometric model*: This option requires large amounts of easily available data to feed the model. Also, it assumes that no major policy changes will occur during the forecast period.

- *Using an expert-based approach*: This option is much better adapted when data availability is a constraint and/or when significant policy changes are anticipated during the forecast period. Most countries being in that situation, it is recommended to use a crop-based, expert-based approach. In addition, contrary to what is often believed, expert-based models are not "second class" approaches compared to econometric models.

The purpose of this document is to present a crop-based, expert-based methodology that can be used on a consistent basis across all countries and regions. It is believed that this methodology can yield more accurate forecasts of fertilizer consumption in that it is based on the underlying factors driving demand rather than on just past aggregate consumption trends.

Developing a Crop-Based, Expert-Based Forecast

While each methodology has its own merits and shortcomings, it is believed that the crop-based, expert-based approach to developing a forecast for fertilizer demand is likely to be more accurate on a consistent and long-term basis. The crop-based approach will also yield more information about fertilizer consumption that can prove to be valuable to researchers, planners and policy makers.

Using the crop-based, expert-based methodology for forecasting fertilizer demand requires a good (expert) knowledge and understanding of local fertilizer markets, as well as knowledge of a number of market fundamentals such as crop prices, expected planted area by crop, fertilizer prices and fertilizer use by crop. In addition, factors such as evolution of trade, agricultural and environmental regulations, soil moisture/water availability and soil nutrient levels can be important indicators of the demand for fertilizer.

To provide a guideline for forecasting the country demand for fertilizer inputs, the process can be broken into four stages.

Stage I The first stage of a crop-based, expert-based forecast is developing a historical database by nutrient by crop.

Stage II The second stage consists in developing a qualitative scenario for the forecast period, looking at the different factors likely to influence domestic agriculture and fertilizer demand.

Stage III The third stage involves developing a quantitative forecast for fertilizer demand according to the scenario developed in Stage II.

Stage IV The fourth and final stage is the validation stage, where the final projections are reviewed for reasonability and/or, possibly, cross-checked with other forecasting methodologies.

It is critical to follow this four-stage approach to develop a sound forecast. In particular, establishing a sound historical database (Stage I) is probably the most important step of the whole process. Developing a qualitative scenario is also an essential step before developing the quantitative forecast, which is the ultimate objective. All the stages of that approach require an expert knowledge of the driving forces that will influence fertilizer consumption.

Stage I – Developing a Historical Database

The first stage in developing a crop-based, expert-based forecast for fertilizer demand is to establish a historical database. This is by far the most critical aspect of the forecasting procedure.

One of the key aspects of a crop-based forecast is that it gives the users of the data insight as to where and why the growth (or decline) in demand is occurring and to identify possible trends and patterns. In contrast to the trend and/or growth forecasts, which typically include only aggregate consumption by nutrient (see Annex 1 for details on other forecast methodologies), the crop-based approach also includes data on (i) the area planted to the main crops, (ii) the percent area fertilized by nutrient by crop and (iii) the average fertilizer application rates by nutrient by crop on the fertilized area.

Box 2: Definitions

Percent area fertilized: The percent area fertilized refers to the portion of the total area planted to a particular crop that received an application of a particular nutrient.
For example, if there were 100 hectares of maize grown in country XYZ, and half of the area received a balanced application of NPK, then the percent area fertilized for each nutrient would be 50%. However, if instead of a balanced fertilization programme, nitrogen was applied to 50 hectares, phosphate to 30 hectares and no potash was used, then the percent area fertilized would be 50% for nitrogen, 30% for phosphate and 0% for potash.

Average nutrient application rate: The average nutrient application rate refers to the average consumption of fertilizer of a particular nutrient applied on a particular crop for a particular growing season. The rate applied is expressed in kg nutrient per hectare.
For example, if it is a common practice to use a pre-plant fertilizer application on a particular crop, followed by a side-dress application, the application rate for each nutrient on that crop would include the total volume used in the two applications.
It is important to recognize that the average nutrient application rates differ from the recommended nutrient application rates. Collecting and comparing these two different sets of data is useful, as it indicates the theoretical growth potential.

In addition to the above parameters, it might be useful to collect data on crop yield (or alternatively on crop production), which can help to explain the evolution of application rates.

The importance of this data can be illustrated by looking at phosphate fertilizer demand in the United States from 1998 to 2005. As shown in Chart 1, demand has fluctuated between 4.2 and 4.8 million short tons. The aggregate consumption data, however, yields no information about the reasons for this fluctuation. Using the crop-based approach, most of the variability in consumption can be identified. As can be seen in Table 1, most of the volatility in demand has been on corn (maize) with most of that volatility due to fluctuations in the area planted rather than in application rates. This is critical information when trying to put together a forecast.

Chart 1: US phosphate demand by crop (million short tons)

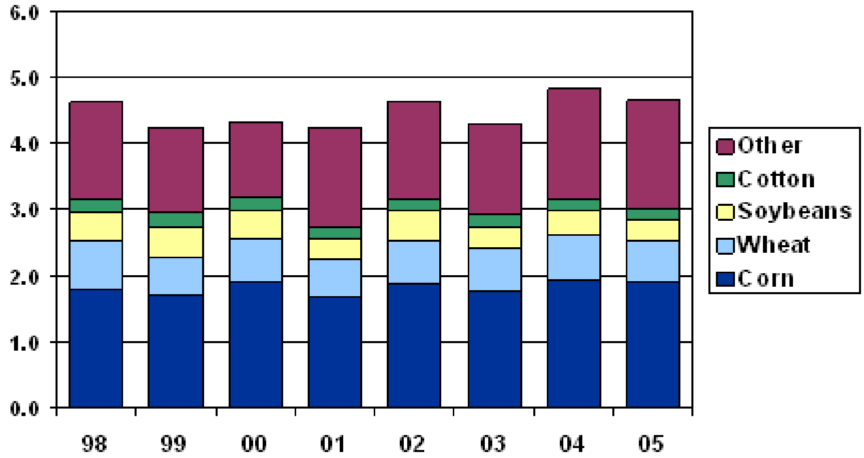


Table 1: US phosphate demand by crop

	1998	1999	2000	2001	2002	2003	2004	2005
Corn								
Area Planted (Acres)	80.2	77.4	79.6	75.7	78.9	78.6	80.9	81.8
% Fertilizer with P	83	82	84	79	79	77	79	79
Application Rate (lb/Ac)	54	54	57	56	60	58	61	59
Rate per Acre Planted (lb/Ac)	45	44	48	44	47	45	48	47
P Use on Corn (Short Tons)	1,796	1,713	1,904	1,675	1,870	1,769	1,942	1,921
Wheat								
Area Planted	65.8	62.7	62.6	59.4	60.3	62.1	59.7	57.2
% Fertilizer with P	63	62	62	62	62	61	62	61
Application Rate	35	30	33	31	35	34	35	34
Rate per Acre Planted	22	19	20	19	21	21	22	21
P Use on Wheat	726	583	641	571	645	638	656	601
Soybeans								
Area Planted	72	74	74	74	74	73	75	72
% Fertilizer with P	24	26	24	17	26	19	21	19
Application Rate	48	46	48	49	49	46	48	45
Rate per Acre Planted	12	12	12	8	13	9	10	9
P Use on Soybeans	415	441	428	309	471	319	376	307
Cotton								
Area Planted	13.4	14.9	15.5	15.8	15.8	14.0	13.5	13.7
% Fertilizer with P	66	59	63	48	50	53	54	55
Application Rate	48	49	46	43	45	48	49	48
Rate per Acre Planted	32	29	29	21	23	26	27	27
P Use on Cottom	212	215	225	163	177	179	179	181
Other Crops								
Area Planted	98.6	100.9	96.4	99.6	98.4	97.6	93.1	94.0
% Fertilizer with P								
Application Rate								
Rate per Acre Planted	30	26	23	31	30	28	36	35
P Use on Other Crops	1,466	1,302	1,116	1,540	1,467	1,385	1,660	1,645
Total Phosphate Use	4,615	4,254	4,314	4,257	4,630	4,291	4,813	4,655

Aggregate consumption data by nutrient for a particular country is readily available from a number of sources including IFA and FAO. The area planted to the major crops is often readily available from government agencies and a number of other sources. In case data on the planted area is not available, the harvested area can be used as a proxy. An average conversion factor by crop can be used for estimating the planted area from harvested area data [Note: FAO provides statistics on the harvested area, not on the planted one]. The most difficult data to acquire is the percent of the area fertilized and the average nutrient application rates by crop because:

- only a very limited number of countries have government agencies that collect such data;
- where data is collected, the coverage is typically restricted to a few major crops and/or the data is not reported on an annual basis; and
- various cropping practices, such as mixed-cropping and multiple-cropping, make it difficult in trying to determine what fertilizer went on what crop.

Box 3: How to deal with the "other crops" category?

The database should at least contain information on the main fertilizer-consuming crops, which can be very few in countries with limited crop diversity (e.g., in Malaysia, oil palm and rice together account for most of domestic fertilizer consumption). On the contrary, in countries with a highly diversified agriculture such as China, the number of crops to be considered might be quite significant, including some fruits and vegetables (rice, wheat, maize, soybean, rapeseed, cotton, sugarcane, tomatoes, cabbages, apples, etc.). The "other crops" category usually includes minor grain, oilseed, sugar, fiber and herbage crops, fruits, vegetables and ornamentals.

For an accurate crop-based forecast, crops included in the "other crops" category should, to the extent possible represent a small share of total domestic fertilizer demand. However, if reliable data are available for a few crops only, it is better to make a precise assessment of these few crops, and then extrapolate to 100% of the known fertilizer consumption, using the "other crops" category.

If official published data is not available, other sources of information on the area fertilized and application rates may be available through agronomic periodicals, farm management publications, etc. It may also be helpful to establish a network of knowledgeable individuals to assist in the process. Such individuals may include university agronomists, fertilizer-marketing managers, agricultural extension specialists and other individuals involved in agriculture and/or fertilizer marketing.

Assuming the percent area fertilized and the application rate data is not available, there are different methods of trying to estimate this data (see Box 4).

Box 4: Assessing the percent area fertilized and average application rates

The ***first method*** involves "backing into" the data. The first step in this method is to identify which crops are to be estimated. While it would be ideal to be able to identify fertilizer use on all crops, this is not always possible. The next step is to roughly allocate by nutrient how much you believe is being used on each of these crops with the remaining amount being classified as "other crops".

By dividing the estimated volume for each nutrient by the total area planted to that crop, the rate per planted area or "nutrient effective rate" can be derived as follows:

$$\frac{\textit{Estimated volume for nutrient}}{\textit{Estimated total area planted}} = \textit{Nutrient effective rate}$$

The next step is to give your best estimate (this may again require the assistance of others) of either the average nutrient application rate or the percent area you believe is actually being fertilized. If the average nutrient application rate was estimated, then the percent area fertilized can be derived by dividing the nutrient effective rate by the estimated average nutrient application rate as follows:

$$\frac{\textit{Nutrient effective rate}}{\textit{Average nutrient application rate}} = \textit{Percent area fertilized}$$

If the percent area fertilized was estimated, then the average nutrient application rate can be derived by dividing the nutrient effective rate by the percent area fertilized as follows:

$$\frac{\textit{Nutrient effective rate}}{\textit{Percent area fertilized}} = \textit{Average nutrient application rate}$$

The ***second method*** is to directly estimate the average nutrient application rate and the percent area fertilized for each crop being considered. Multiplying these two estimates will yield the nutrient effective rate. Multiplying the nutrient effective rate by the area planted will yield your estimate for how much N, P or K is being used on each crop. Add the results for each crop being estimated and compare this to the total aggregate estimate for each nutrient. The difference should be the amount of each nutrient that is being used on all "other crops". The estimate of the "other crops" should be reasonable and relatively consistent over time. If not, then it may be necessary to go back through the process and adjust the nutrient application rate and/or percent area fertilized for those crops you believe may have been over- or under-estimated.

In some cases, it may be impossible to derive an average nutrient application rate and/or a percent area fertilized. For example, in the "other crops" category, which may include a variety of different crops, it may be impossible to determine a reasonable estimate for either variable. Under this scenario, the best solution may be to derive a nutrient effective rate and, then, stop.

No matter which method is used, it is important to go back through the data and try to (i) identify why changes have occurred and (ii) determine if the estimates are consistent with the events that may have affected demand in any given year.

Stage II – Developing a Qualitative Scenario

The second stage of the crop-based, expert-based forecast is developing a vision of the anticipated policy framework and market conditions for the forecast period, looking at the different factors likely to influence domestic agriculture and fertilizer demand. Developing this qualitative scenario is an essential component of an accurate forecast, because it will provide arguments supporting the foreseen trends of the crop parameters that influence fertilizer consumption.

Developing the scenario requires collecting and analyzing information on the anticipated evolution of:

- the economic context at the national level, and at the regional and global levels where relevant;
- agricultural, trade and environmental policies that might impact domestic agriculture during the forecast period, with particular attention to the prospects for import/export of agricultural products;
- fertilizer policies or regulations that might influence fertilizer demand, such as fertilizer subsidy policies;
- the market for the main agricultural commodities and resulting crop prices and fertilizer-to-crop price ratio;
- the crop mix and incentives for raising agricultural productivity in response to market and policy signals;
- agricultural technologies and practices that might impact fertilizer demand and, in particular, nutrient use efficiency.

This information can be collected from a number of national and international sources. More details on needed/useful information are given in Annex 2.

As an example, an interesting factor to take into account in developing forecasts is the likely impact of bioenergy developments in a number of countries. How will these developments, driven by a favourable policy context in a number of countries, impact the crop mix, crop prices, crop productivity and, therefore, fertilizer use on bioenergy crops? These are questions that need to be answered when developing the scenario. These issues need to be addressed taking the global context into account, because some countries might decide to import feedstock rather than producing bioenergy crops domestically; some others with significant arable land reserves could decide to convert more land to cropping, thus impacting the planted area. Also, bioenergy production generates substantial amounts of co-products, which are often used as animal feed. This will impact feed grain production and trade in some countries.

Agricultural policy reforms have also a great impact on the crop parameters that influence fertilizer demand. For instance, the sugar beet reform in the European Union is resulting in a considerable shrinking of the area planted to that crop, essentially to the benefit of cereals and oilseeds. At the same time, the policy on biofuels triggers the strong development of oilseed rape. In the next few years, the mandatory set-aside policy (10% of the cultivated area under set-aside) is expected to be discontinued, thus resulting in an anticipated increase of the planted area. However, this increase is not expected to be proportional, because a quite significant share of the mandatory set-aside area is likely to be converted to voluntary set-aside. Such an analysis of the main driving forces can be done for all countries. The possibility to take the expected impact of policy changes into account is one of the main strengths of an expert-based approach.

Stage III – Developing the Quantitative Forecast

The third stage involves developing a quantitative forecast for fertilizer demand according to the qualitative scenario developed under Stage II. This phase requires assessing the impact of anticipated market conditions on the crop parameters influencing fertilizer consumption, namely the area planted to the main crops, the percent area fertilized for the main crops and average fertilizer application rates by nutrient by crop.

Box 5: Two approaches for developing medium-term fertilizer demand forecasts

There are basically two ways of developing medium-term (e.g. 5-year) fertilizer demand forecasts:

- The first one is a step-wise approach: start with year+1, then year+2, etc. until year+5;
- The second one is to develop first the forecast for year+5 according to the scenario, and then interpolate between the base year and year+5.

Both options have advantages and disadvantages. The second option is however more suitable for medium- to long-term projections (e.g. 10-year forecasts).

Forecasting the evolution of the planted area

The first step of the quantitative forecast is to develop projections of the area planted to the main crops. Forecasts of the planted area (or of the harvested area in case planted area projections are not available) can be acquired from a number of sources including government agencies, international organizations, consultants or your organization.

The planted area in a country can be influenced by a number of factors such as crop prices, weather conditions, government policies, etc. In order to determine what variables impact the planted area and the magnitude of that impact, it is often helpful to analyze historical data patterns and identify what factors impacted past changes in planted area. For example, the area planted to cotton in the United States has been gradually trending downward over the last 20 years. This has been due to two key factors: (i) a decline in exports – a result of an increase in foreign competition and (ii) a decline in domestic demand driven by a gradual increase in the use of synthetic and blended fibers. While the overall trend has been down, there has been a considerable amount of short-term variability due to a variety of factors such as increases/decreases in cotton prices, changes in prices of alternative crops that could replace cotton (maize, grain sorghum), changes in government policies, and reoccurring droughts in the Texas/Oklahoma area. In developing a forecast for cotton acreage in the United States, the downward trend in area planted has to be analyzed to see if that trend is likely to continue and, if not, what factors will likely change the outlook.

In trying to forecast the area planted by crop for a particular country, specific areas in a region may also have to be identified and analyzed. For example, virtually all of the variability in cotton area in the United States is in the Eastern part of the country while cotton area in the Western United States is expected to remain relatively stable. The reasons for the stability in the Western part of the country is that most of the cotton grown in this area is under irrigation, grown on very large farms (as much as 10,000 hectares) and is a different variety of cotton with a less volatile market.

For many countries, it may also be important to segment the forecast for a particular crop. For example, fertilizer consumption on irrigated crops is typically higher than on rainfed areas (e.g. in rice and maize). Similarly, in some countries, fertilizer application rates on winter wheat are significantly different from the rates used on spring wheat.

For some countries, specific cultural practices may have to be considered when developing the historical database and the planted area forecast. A list of some of these practices is given in Box 6.

Forecasting the evolution of the percent area fertilized and of average nutrient application rates

The second step of the quantitative forecast is to develop estimates of the quantity of each nutrient that is being used on a per planted area basis. This involves developing a forecast of two linked, but separate components: the "percent area fertilized" and the "average nutrient application rate". This is where the historical data becomes important in that it allows the analyst to look back in history to try to identify how much volatility typically occurs in these variables and what factors cause the changes.

Fertilizer application practices are influenced by a wide variety of economic and environmental factors. One of the most important factors influencing demand is crop price. Obviously, higher crop prices will likely induce farmers to apply higher rates of fertilizer, while low crop prices could have a negative impact on both application rates and the percent area fertilized. Fertilizer prices will have the opposite impact. However, fertilizer prices typically have less of an impact on consumption when crop prices are high and more of an impact when crop prices are low. Crop prices and fertilizer prices also tend to have more of an impact on phosphate and potash demand than on nitrogen demand. Environmental factors such as soil moisture and weather conditions can also have a major impact on the short-term outlook for fertilizer demand. Inadequate monsoons, for example, can impact the current year's forecast as well as the second year of the forecast depending on the severity of the drought.

The current level of fertilizer adoption within a country is another important variable to assess. In most developed countries, the percent of the hectares being fertilized is already very high, with little room for growth. In many developing countries this percentage is significantly lower and has the potential for significant growth, in particular for phosphate and potash.

Box 6: Specific agricultural practices that deserve particular attention

Non-harvested crops*:* In case the planted area would not be harvested due to adverse conditions or pest problems, data should refer to the "planted" area, as opposed to the "harvested" area, since the non-harvested crop would probably have received fertilizers either before or shortly after planting. If "planted" area data are not available, information on the share of the "planted" area that has not been "harvested" should be collected, in order to assess the "planted" area based on available "harvested" area data.

Multiple cropping*:* This refers to crops grown successively over a year on the same plot of land (e.g. rice-wheat rotation in India). In this situation, the entire area planted to each crop should be reported for that particular crop.

Mixed cropping*:* This is a common practice in the tropics/sub-tropics. The problem of estimating crop area under a multiple cropping system is determining how much of the planted area is assigned to each crop. It is recommended that the total area under mixed cropping be divided using the average seed rate or area sown under each crop. If this is not possible, a simple way is to assign the total area to the major crop sown on the field. Which crop is considered to be the major crop can be determined by a number of different methods, including the seeding rate, the crop that yields the highest revenue, or any other method considered to be appropriate by the individual preparing the data.

Perennial crops*:* These crops have generally a long gestation period, which may take more than five years of fertilization before the first harvest. In this case, data should refer to the "planted" area, as opposed to the "harvested" area. If "planted" area data is not available, it is possible to use "harvested" area data using a conversion factor. For instance, if the gestation period of crop XYZ would represent on fifth of the total life spam of the plantation, the conversion factor would be 80 percent.

Continuous planting*:* In the case of crops grown under continuous planting (e.g. cassava), the data for the planted area should include the entire area under the crop and be reported on an annual basis irrespective of the planting and harvesting cycle.

Changes in government policies represent another area that can impact both short-term and longer-term fertilizer application practices. In Europe, for example, increasingly stringent environmental regulations have had a major impact on both nitrogen and phosphate application rates. Government policies that impact farm income (ex. direct payments, low interest rate loans, disaster payments, etc.) and the overall level of government support to agriculture (research, extension, infrastructure development, etc) are also factors that may have to be considered when developing a crop-based forecast. Countries that are export-oriented and with little financial support to their farming sector (e.g. Brazil, Argentina, Australia, New Zealand) respond quickly to market signals and have a much more volatile domestic fertilizer market.

As discussed in Stage I, application rate data or percent area fertilized is not always available and/or possible to project. In this case, it may be necessary to project the "nutrient effective rate" (see Box 4 for definition). This is particularly true for the "other crops" category, which may include a wide variety of minor crops with significantly different fertilizer practices.

Under this scenario, the best option is to project the nutrient effective rate using a trend analysis or any other methodology that appears consistent with the historical data.

Developing the fertilizer demand forecast

Once the forecasts for the planted area, the percent area fertilized and average nutrient application rates have been completed, the fertilizer demand forecasts by nutrient by crop can be derived. This is the easiest part of the exercise in that the total for each nutrient is derived by multiplying the planted area by the percent area fertilized and the average nutrient application rate, and converting the number to thousands of metric tonnes.

It is important that data be provided for as many crops as possible, in particular for the main fertilizer-consuming crops. In some instances, "educated guesses" may have to be made. Educated guesses can be surprisingly accurate if based on sound assumptions and/or reasonable anecdotal information.

Table 2: Crop-based forecast for country XYZ

	Hectares Planted	Percent of Area Planted			Application Rate (Kg/Hectare)			Total Consumption (000 tonnes)		
		N	P2O5	K2O	N	P2O5	K2O	N	P2O5	K2O
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Maize										
Current Year	22.0	60%	46%	35%	73	35	20	964	354	154
Year 2	22.0	63%	47%	37%	73	35.1	20.1	1012	363	164
Year 3	21.5	65%	48%	38%	73	35.2	20.2	1020	359	164
Year 4	21.0	67%	48%	39%	73.1	35.3	20.3	1021	356	164
Year 5	21.5	67%	49%	39%	73.2	35.4	20.4	1054	369	172
Soybeans										
Current Year	11.0	0%	35%	30%	0	15	10	0	58	33
Year 2	10.5	0%	36%	30%	0	15	10	0	57	32
Year 3	11.0	0%	36%	30%	0	15	10	0	60	33
Year 4	11.5	0%	37%	30%	0	15	10	0	63	35
Year 5	12.0	0%	37%	30%	0	15	10	0	67	36
Wheat										
Current Year	14.5	50%	40%	30%	40	20.5	15	290	119	65
Year 2	14.0	50%	40%	30%	41	21	15	284	118	63
Year 3	14.5	50%	40%	30%	41	21	15	298	122	66
Year 4	15.0	50%	40%	30%	42	22	15	313	133	68
Year 5	15.0	50%	40%	30%	42	22	15	318	133	68
Other										
Current Year	11.0							83	17	9
Year 2	11.5							83	17	9
Year 3	11.0							84	17	9
Year 4	11.5							85	17	9
Year 5	12.0							84	17	9
Total										
Current Year	58.5							1336	547	261
Year 2	58.0							1379	555	268
Year 3	58.0							1403	558	271
Year 4	59.0							1419	570	276
Year 5	60.5							1456	586	286

An example of a hypothetical crop-based forecast is shown in Table 2. In this example, country XYZ grows approximately 20 million hectares of maize, 10 million hectares of soybean, 15 million hectares of wheat and 10 million hectares of "other crops". The "other crops" category would include those crops where data is simply not available and estimates could not be made. Although not included in this example, there may be occasions where reasonable estimates can be made for the total amount of fertilizer being used on a particular crop, but not for either the percent area fertilized or the application rate. In this case, the crop should be taken out of the "other crops" category and the fertilizer consumption estimates listed under the name of the crop. The percent area fertilized and the application rate columns for that crop would be left blank.

After the estimates for each crop have been completed, the individual crop estimates are summed for each nutrient.

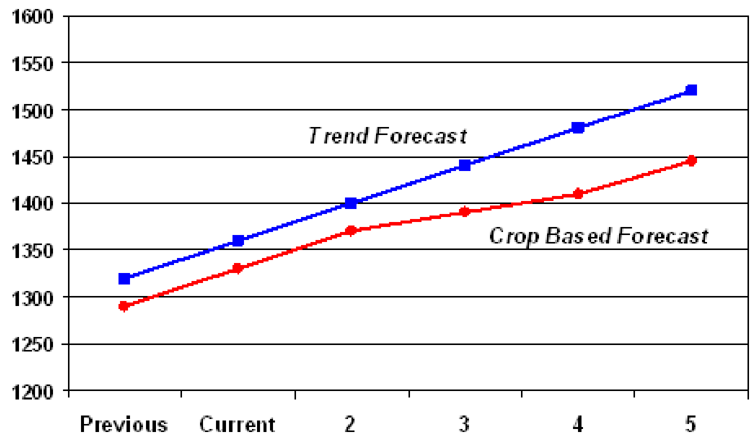
Stage IV - Validation of the Forecast

The final stage in the development of a crop-based forecast is the validation phase, where the projections are determined to be reasonable. This can be accomplished by comparing the total projections by nutrient with the country's official consumption estimates for the previous year and/or compared to other forecasts of aggregate demand using different methodologies. If the summed total from the crop-based forecast appears reasonable for each nutrient, then the exercise is complete. However, if one or more of the nutrient totals appear to be inconsistent, then it may be necessary to re-evaluate the individual crop data to see if any adjustments need to be made.

The validation phase can be illustrated by using the example from the previous section. Assuming that the official statistics for Country XYZ for the previous year were equal to 1.20 million tonnes of N, 550,000 tonnes of P_2O_5 and 260,000 tonnes of K_2O, it would appear that the nitrogen forecast is too high. While demand could increase in a particular year by the 10 percent assumed in this example, it is doubtful that the longer-term forecast could be maintained at that level, even if governmental targets would support such an increase. In this case, it appears that the individual crop forecasts for nitrogen should be re-assessed and, possibly, adjusted downwards.

It may also be helpful in determining the validity of the forecast to compare it with other forecast methodologies. A hypothetical nitrogen trend line for Country XYZ versus the crop-based forecast from the previous example is shown in Chart 2. As can be seen, the trend forecast is consistently higher than the crop-based forecast, and approximately 5 percent higher in the fifth year. This would imply that the growth rate for nitrogen in Country XYZ is beginning to slow down. If this appears reasonable to the individual(s) developing the forecast, then no other adjustment may be necessary. If not, then again, the individual crop forecasts may need to be re-assessed.

Chart 2: Nitrogen fertilizer consumption in country XYZ



Annex 1

Types of Forecasting Methodologies

There are a number of different methodologies that can be used to develop forecasts of fertilizer demand. The following is a list of some of these forecast methodologies along with some of the advantages and disadvantages associated with each method.

1. Trend Analysis

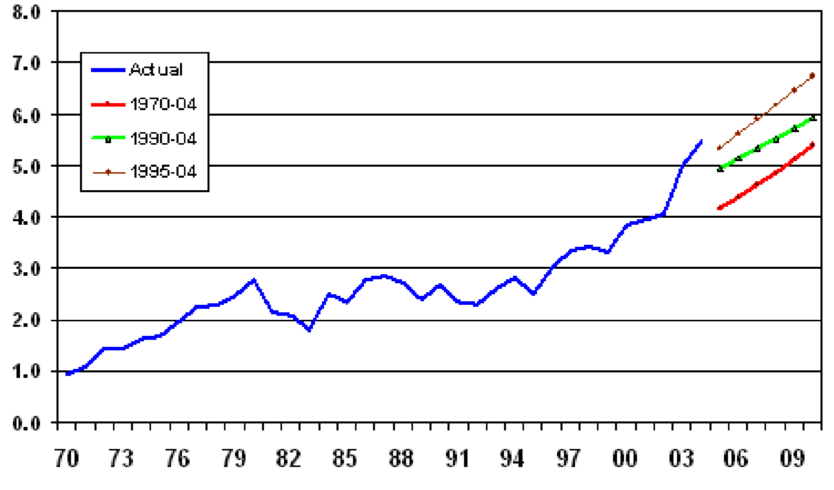
Forecasts are based on historical values and typically generate straight-line results.

Positive:
- Relatively easy to do;
- Requires minimal amounts of data.

Negative:
- Does not take into consideration the factors impacting demand;
- Typically, cannot identify structural changes until after they have already occurred;
- Forecast can vary significantly depending on the starting and ending points used to determine the trend line.

The latter is of critical importance and probably the most significant limitation when using trend analysis. For example, Chart 3 shows the forecast for Latin American phosphate demand under various starting and ending points. As can be seen, the results vary dramatically with the forecast for 2010 ranging from 5.4 million tonnes using the 1970 through 2004 data, to 5.9 million tonnes using the 1990-2004 data, to 6.7 million tonnes using the 1995-2004 data.

Chart 3: Forecasts using trend analysis
(Latin America phosphate demand)



Source: IFA

2. Growth Rate Models

Forecasts are typically generated by calculating historical growth rates and applying the calculated rates to future years.

Positive:
- Relatively easy to do;
- Requires minimal amounts of data.

Negative:
- The negatives associated with this type of analysis are similar to those for trend analysis in that it does not take into consideration the factors impacting demand;
- The nature of compounding annual numbers can result in unrealistic forecasts as the estimates move further into the future;
- The forecasts can vary significantly depending on the end points used to calculate the growth rate. This is particularly problematic in markets that exhibit any degree of volatility;
- The forecasts are typically applied to the latest "actual" data. As a result, the forecasts are by definition, biased by what happen during that "actual" year.

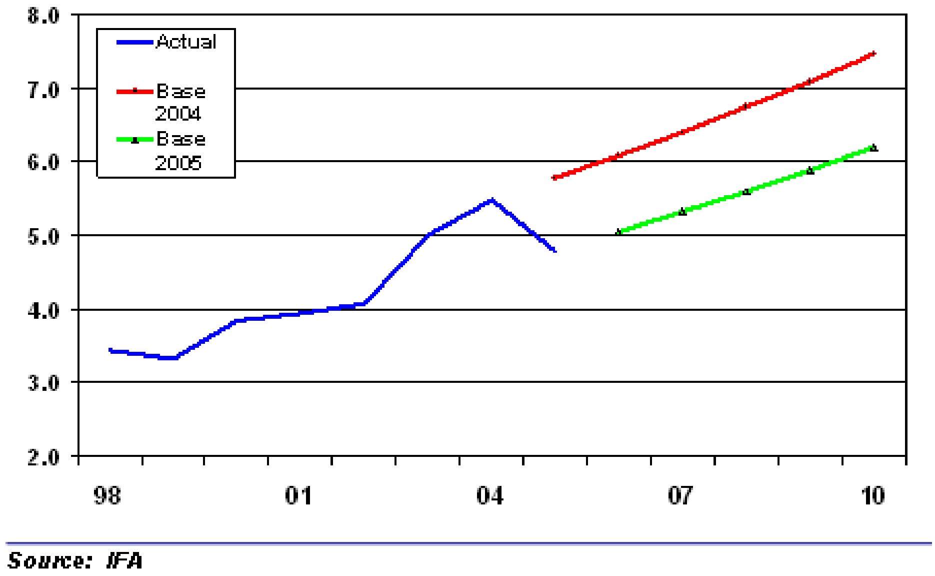
Forecasts based on growth rates are typically the least accurate method for forecasting fertilizer demand and can yield significantly different results depending on which years are used to calculate the growth rates. Table 3 below shows the calculated growth rates using different starting years and 2004 as the end year. As can be seen, the growth rates vary from 2.9 percent for the 1980 to 2004 period to over 9 percent growth using 1995 to 2004 and 2000 to 2004 periods. These growth rates result in a 2010 forecast ranging from 6.5 to 9.3 million tonnes.

Table 3: Forecasts using growth rates
(Latin America phosphate demand)

Base Year	Average Annual Growth Rate Base Year to 2004	Calculated Forecast for 2010 (MM Tonnes)
1970	5.4%	7.5
1975	4.2%	7.0
1980	2.9%	6.5
1985	4.6%	7.2
1990	5.3%	7.5
1995	9.1%	9.2
2000	9.3%	9.3

The fact that the forecast growth rates are typically applied to the latest "actual" year can also be problematic, particularly if the "actual" year was unusually high or low. This occurs quite often and can be caused by a variety of factors (ex. drought, rapid increases/decreases in output or input prices, etc.) that are unlikely to occur again during the forecast period. The inherent bias in the forecast is illustrated using Latin American phosphate demand for 2004 and the latest estimate for 2005. As can be seen in Chart 4, when the 1990-2004 growth rate of 5.3 percent per year is applied to 2004 data the forecast for 2010 is estimated at 7.5 million tonnes. When applied to the estimated 2005 data, the 2010 forecast drops to 6.2 million tonnes.

Chart 4: Forecasts using growth rates
(Latin America phosphate demand)



3. Production/Trade Models

Forecasts are developed using industry capacity assumptions and assumed production and trade estimates.

Positive:
- Relatively simple model that is easy to do;
- The production and trade data used to calculate the demand estimates are usually reliable and, in most cases, is readily available.

Negative:
- Forecasts using this methodology tend to estimate the potential supply availability rather than fertilizer consumption;
- Requires forecasts of capacity, production levels and trade data by product. Also requires forecasting non-ag/industrial demand for each fertilizer product;
- Forecasts typically include only region/country nutrient totals and do not give information on a crop basis.

Production/trade models can be a useful tool in cross-checking historical demand data. However, forecasts based on production/trade models typically don't work due to the fact that in most countries demand for fertilizers is not driven by supply, but rather by factors such as acreage, crop prices, etc.

4. Econometric Models

Forecasts are statistically derived using independent variables that are considered to be the primary factors in determining demand. This methodology is typically used for estimating aggregate demand or estimating a specific variable.

Positive:
- Can be used to mathematically estimate the impact on demand of a change in a specific independent variable or a mix of variables;
- Is useful as an explanatory tool, particularly if large changes in demand have occurred over a period of time.

Negative:
- Requires a large historical database;
- Often difficult to derive equations that are statistically significant and have statistically significant variables;
- Typically requires separate forecasts of the independent variables;
- Models must be continually updated and re-estimated;
- Often difficult to model and/or forecast structural changes in demand;
- Requires specific training in econometric/statistical analysis.

This type of forecast can be very helpful in determining the impact of a specific variable or mix of variables on a specific dependent variable. For example, an econometric model can be helpful in trying to estimate application rates of a particular nutrient on a specific crop given changes in crop prices and/or fertilizer prices. It can also be used as a cross check on a forecast done using another methodology.

5. Crop-Based Models

Forecasts are derived from the “bottom up” using estimates for area planted, percent fertilized and application rates on a crop by crop basis.

Positive:
- Forecasts are typically more accurate on a long-term basis;
- Provide information on nutrient demand on a crop by crop basis;
- Allows researchers and users of the data to more specifically identify where changes in demand are occurring.

Negative:
- Requires specific knowledge of local crops and fertilizer markets;
- May require a large number of participants to accumulate the required data and report it on a consistent basis.

Annex 2

Checklist of Information Needed for Developing the Base Year and the Scenario

Information needed for developing the base year

Information explaining the base year

- Global, regional and national agricultural context (agricultural production, trade and consumption, agricultural commodity prices)
- Weather conditions
- Government's policy (agricultural, trade and environmental policies)
- Economic context

Statistics and past trends for

- The total cultivated area
- The area planted to the main crops (use the area harvested as a proxy if planted area data are not available)
- Percent area fertilized for the main crops
- Actual average nutrient application rates for the main crops

Other useful data

- Yield levels for the main crops
- Recommended fertilizer application rates for the main crops
- Fertilizer prices
- Use of other nutrient sources (animal manure, urban wastes…)
- Nutrient use efficiency

Information needed for developing the forecast

Information explaining future trends

- Global, regional and national agricultural context (production, trade and consumption)
    - Crop production
    - Animal production
    - Biofuel/bioenergy production
    - Evolution of farm management practices (including fertilization practices)
- Weather conditions, soil moisture and water reserves (for short-term forecasts) and climate prediction (for medium- to long-term forecasts)
- Government's policy (agricultural, trade and environmental policies)
    - Government's objectives
    - Do they fit in the global and regional contexts?
    - What can be reasonably achieved; what are the trade-offs?
- Economic context

Projections on

- The total cultivated area
- The area planted to the main crops
- Yield levels for the main crops
- Percent area fertilized for the main crops
- Actual average nutrient application rates for the main crops

Other useful data

- Recommended fertilizer application rates for the main crops
- Fertilizer prices (for short-term forecasts)
- Use of other nutrient sources (animal manure, urban wastes…)
- Likely improvements in nutrient use efficiency

Sources of information

- Global outlook reports by FAO, OECD, FAPRI, USDA, ABARE…
- Government agencies: Ministries of agriculture, trade, environment…
- Extension services, universities, agricultural research institutes…
- Surveys on farmers' practices
- Agricultural journals
- Fertilizer companies
- Other input suppliers: crop protection industry, seed industry…
- Farmers' cooperatives and associations