CROSSROADS
ASIA PACIFIC

KUALA LUMPUR
MALAYSIA
20-22 OCTOBER 2015

Training on Fertilizer Demand Forecasting (Theoretical Session)

Patrick Heffer and Armelle Gruère, IFA

What Is IFA?

IFA in Brief

- ✓ Non-governmental organization representing the world fertilizer industry
- ✓ About 550 members in more than 80 countries
- ✓ Based in Paris
- ✓ Organized around 4 standing committees:
  - Technical, Safety, Health & Environment
  - Production & International Trade
  - Agriculture
  - Communication & Public Affairs
- ✓ Main activities: market analysis, issue management/ advocacy, BMPs & BATs, conference organization

IFA Agriculture Committee

MISSION

To promote sustainable fertilizer management, **conduct authoritative market analysis related to fertilizer demand**, and monitor policy, scientific and other developments that may impact present and future demand.

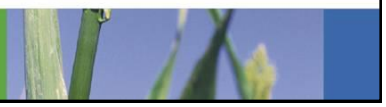
OBJECTIVES

1. Promote **nutrient stewardship**, including effective last-mile delivery;
2. Promote and assist **innovation** related to fertilizer use and **partnership** with the scientific community;
3. Develop timely, reliable and authoritative **fertilizer demand statistics and forecasts**;
4. Address **issues facing fertilizer demand**, including nutrient management policies and fertilizer subsidies;
5. Educate the public about the **role and benefits of fertilizer** in global food and nutrition security.

IFA Agriculture Committee

Develop timely, reliable and authoritative fertilizer demand statistics and forecasts

- ✓ Reports on demand forecasts twice a year
  - Annual Conference (May/June) medium-term (5-year) forecasts
  - Strategic Forum (Nov/Dec) short-term (1-year) forecasts
- ✓ Improving the forecasts
  - Develop network of correspondents
  - Guidelines for a crop-based approach
  - Regional training programmes



IFA Agriculture Committee

Develop timely, reliable and authoritative fertilizer demand statistics and forecasts

- ✓ IFADATA online
  - Historical production, trade and consumption figures
- ✓ Partnership with FAO
  - Historical fertilizer statistics
  - Medium-term outlook for supply/demand balances
- ✓ Other market intelligence activities
  - Fertilizer use by crop
  - Policy monitoring (e.g. fertilizer subsidies)
  - Biofuels, biotechnology…
  - *Nutrient management performance*
  - *Yield gaps and fertilizer gaps*

IFA's Fertilizer Demand Forecasts

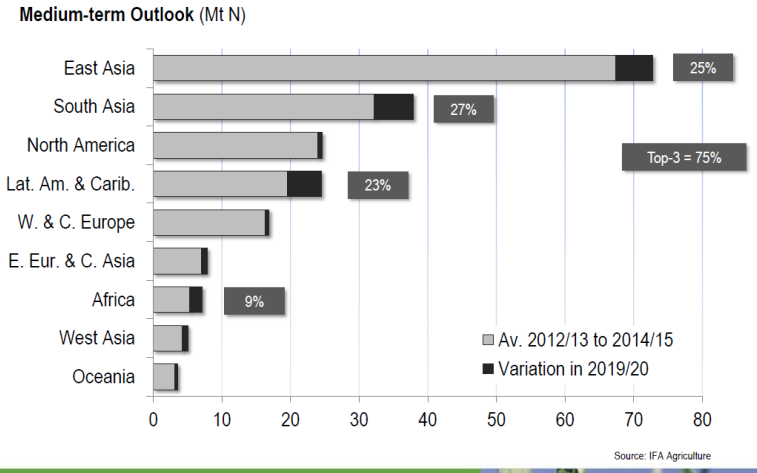
IFA's Latest Forecasts in Brief (May 2015)

Medium-term Forecast (Mt nutrients)

Average Annual Change Base Year → 2019/20	
N	+1.3% p.a.
P_2O_5	+1.8% p.a.
K_2O	+2.6% p.a.
Total	+1.7% p.a.

Source: IFA Agriculture

IFA's Latest Forecasts in Brief (May 2015)



Methodology and Information Used by IFA

Current strategy

- ✓ Rely on information provided by a network of correspondents in ~50 countries
- ✓ But geographical gaps (e.g. Myanmar, Cambodia…)
- ✓ … and very heterogeneous quality
  essentially due to different methodologies used depending on the countries
  - *Trend forecasts*
  - *Government objectives*
  - *Recommended application rates*
  - *Econometric model (e.g. India, Brazil)*
  - *Crop-based / expert-based model (e.g. EU, USA)*

Methodology and Information Used by IFA

Correspondents are not enough

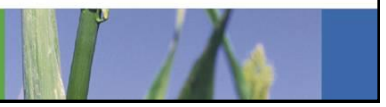
- ✓ Use additional sources of info (reports, articles…) on:
  - Economic context, weather, policy factors
  - Global agricultural situation
- ✓ Check consistency between national forecasts and the global scenario

And checks are needed

Fertilizer demand forecasts are developed independently from but cross-checked with forecasts on the supply side

- To ensure consistency between the two sets
- To issue forecasts on the supply/demand balances

Forecasts provided by the correspondents are revised in more than half of the countries !
They are revised down in most cases.



Importance of Good National Forecasts

National forecasts are the starting point: They provide the foundation for developing regional and global forecasts

Objective

High margin of error

Mostly over-estimation

↓

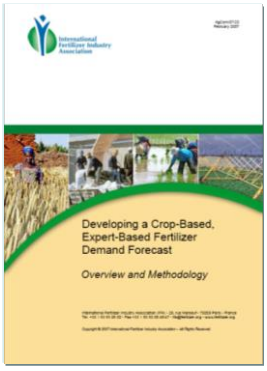
Small margin of error

Balanced fluctuations around actual demand

IFA Training Programme on Fertilizer Demand Forecasts

Objective - Improve national forecasts, which should result in turn in better regional and global projections

- ✓ Developed guidelines for a crop-based, expert-based forecast
- ✓ On-the-ground training programmes



Fertilizer Demand Forecasting Training Meetings

#1: 2006: Kunming, China - *for Asia*

#2: 2007: Bangkok, Thailand - *for Asia*

#3: 2008: Mexico City, Mexico - *for Latin America*

#4: 2009: Rome, Italy - *for Africa and West Asia*

#5: 2012: Rome, Italy - *for Eastern Europe and Central Asia*

#6: 2013: Moscow, Russia - *for Russia*

#7: 2015: Kuala Lumpur, Malaysia - *for Southeast Asia*

Objectives of the Training Sessions

- ✓ Improve the accuracy and reliability of national, regional and global fertilizer demand forecasts
- ✓ Adoption by the IFA correspondents of a crop-based, expert-based forecast at the national level

Programme of the Kuala Lumpur Training

22 October, afternoon:

Crop-based, expert-based fertilizer demand forecast: Overview and methodology

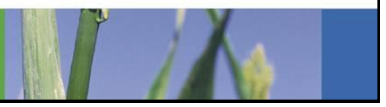
- Why is the crop-based, expert-based forecast the preferred methodology?
- The four stages of a crop-based, expert-based forecast
- Practical recommendations for implementing the crop-based, expert-based forecast

Programme of the Kuala Lumpur Training

23 October, morning:

Working on a practical example: 5-year fertilizer demand forecasts for Malaysia

- Building the historical database
- Developing the scenario for agriculture and fertilizer management
- Developing the quantitative forecast
- Validating the results



Crop-Based, Expert-Based Forecast

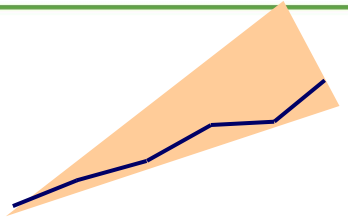
Why Is It the Preferred Methodology?

What is a Good Forecast?

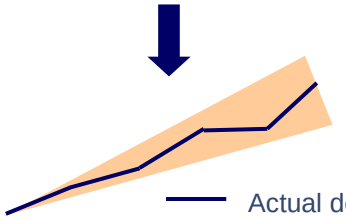
….. the most likely scenario

- ✓ **Independent** from:
  - Commercial pressures
  - Governmental objectives
  - Fertilizer recommendations
- ✓ As **realistic** as possible
  - Not too optimistic → over-investments
  - Not too pessimistic → would endanger food security
- ✓ Often more conservative than governmental targets

Objective of a Good Forecast



- High margin of error
- Mostly over-estimation



- Small margin of error
- Balanced fluctuations around actual demand

Actual demand

Margin of error of forecast

Types of Forecast Methodologies

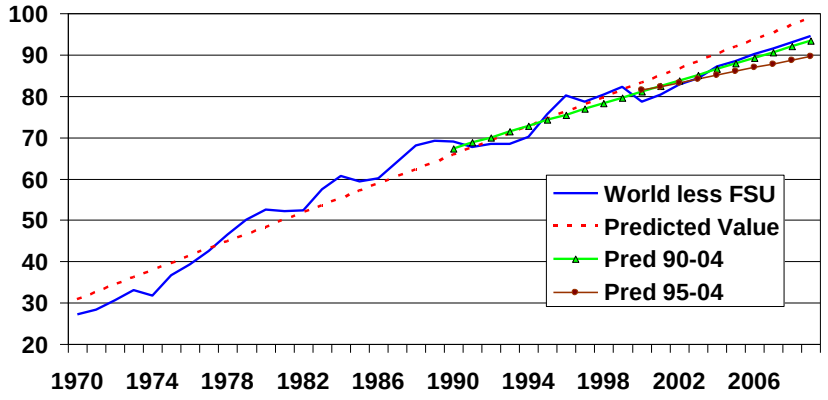
- ✓ Trend analysis
- ✓ Growth rate models
- ✓ Production/trade models
- ✓ Econometric models
- ✓ Crop-based, expert-based models

Trend Analysis

Based on historical values and typically generates straight line results

- ✓ Pros
  - Relatively easy
  - Little data needed
- ✓ Cons
  - Does not take into account factors impacting demand
  - Cannot identify structural changes in demand until after they have already occurred
  - Can vary significantly depending on the starting and ending points

Trend Forecast
World N less EECA



Growth Rate Models

Generated by calculating historical growth rates and applying the calculated rates to future years

✓ Pros
- Relatively easy
- Little data needed

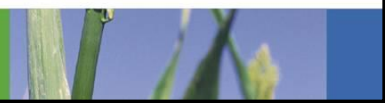
✓ Cons
- Same as for the trend analysis
- Problematic with volatile markets
- Typically applied to the latest actual data → biased by what happened during that year

Least accurate method for fertilizer demand forecasts

Production/Trade Models

Developed using industry capacity assumptions and assumed production and trade estimates

- ✓ Pros
  - Relatively easy
  - Production and trade data are usually available and reliable
- ✓ Cons
  - Tend to estimate potential supply rather than demand
  - Require discriminating non-fertilizer uses
  - Do not work when demand is not supply-driven



Two Ways of Implementing a Crop-Based Forecast

….. using an econometric model

- ✓ Requires large amount of data
- ✓ Assumes no major policy changes will occur during the forecast period

Context met in most countries

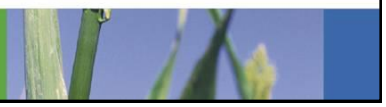
….. using an expert-based model

- ✓ Better adapted when data availability is a constraint
- ✓ Best when significant policy changes are anticipated during the forecast period

Econometric Models

Statistically derived using independent variables considered to be key factors determining demand

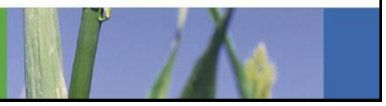
- ✓ Pros
  - Can be used to mathematically estimate the impact on demand of a change in a variable
  - Useful explanatory tool
- ✓ Cons
  - Require a large historical database
  - Often difficult to derive equations that are statistically significant
  - Require forecasts of the independent variables
  - Often difficult to forecast structural changes in demand
  - Require knowledge in econometric analysis



Expert-Based Models

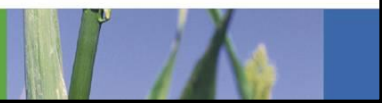
Derived from the bottom-up using crop estimates (area planted, % fertilized and application rate)

- ✓ Pros
  - More accurate on a long-term basis
  - Provide information on nutrient demand by crop
  - Allow to identify where changes in demand are occurring
- ✓ Cons
  - Require knowledge of local crop and fertilizer markets
  - May require several participants to gather the required data



Summary: Which Forecast Methodology should you Use?

Name of Forecast Methodology	Adapted to Fertilizer Demand Forecasting?
Trend analysis	☹
Growth rate models	☹ ☹
Production/trade models	☹
Econometric models	😐
Crop-based, expert-based models	☺



Why Does IFA Recommend Using a Crop-Based, Expert-Based Approach?

- ✓ Can be used on a consistent basis across all the countries and regions
- ✓ Yields much more accurate forecasts than the trend analysis, growth rate models and production/trade models
- ✓ Does not require large databases and knowledge in econometrics as econometric models. Also, more accurate than econometric models
- ✓ Explains where changes in demand are anticipated to come from

Cross-check the outcome of the crop-based, expert-based forecast with a trend analysis, and/or an econometric model, when possible

The Four Stages of a Crop-Based, Expert-Based Forecast

The Four Stages: Overview

Our Goal: "To Arrive at a Realistic, Objective, and Defensible Forecast"

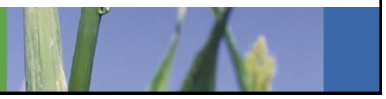
Main Steps:

I. Create a Historical Database or 'Base Year'

II. Develop a Qualitative Scenario: Outlook Conditions

III. Prepare the Quantitative Forecast

IV. Validate the Forecast



I. The Historical Database *Overview*

Consists of data for 3 forecast components:

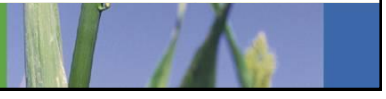
1. Area Planted to Major Crops

2. Percent of Planted Area Fertilized by Nutrient and Crop Type

3. Average Application Rates of Nutrients by Crop Type

+ Develop data for Historical Apparent Nutrient Consumption and Crop Yields

Sometimes historical data are not available
- *Establish data for a Base Year*



I. The Historical Database
Data Collection

Where to get data:

- ***Government Sources (Dept./Ministry of Ag.)***
- ***International Agencies (FAO/IFA)***

Other sources:

- ***University Sources/Agronomic Periodicals***
- ***Farm Publications***
- ***Consultants***
- ***Your "Agricultural Network"***

Example: USDA Website

I. The Historical Database
Data Collection

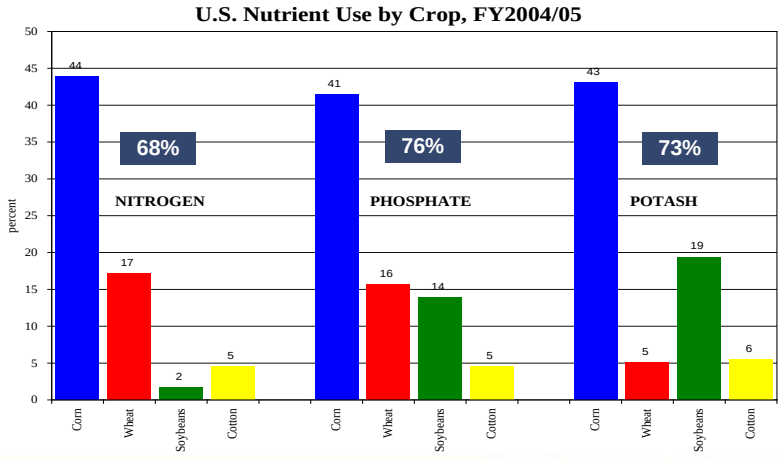
1. Area Planted to Major Crops

- ***Identify the major nutrient-consuming crops***
- ***Collect data on planted area for major crops and other crops***

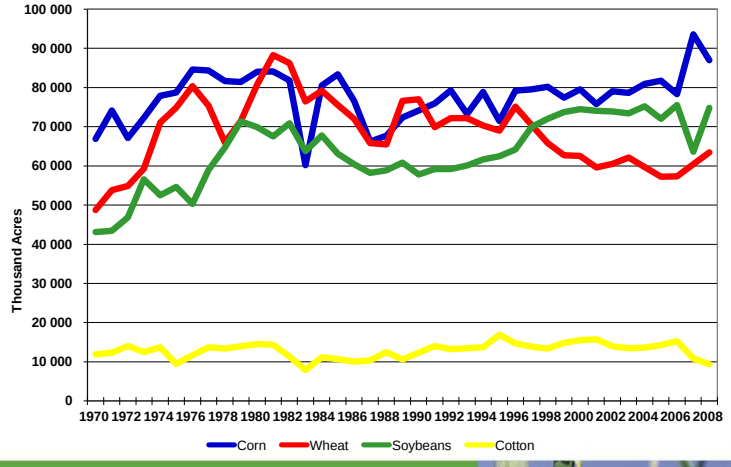
Potential Problems:

- ***Only harvested area data are available***
- ***Data only available for some/few crops***

Nutrient Use – Major U.S. Crops



Acres Planted – Major U.S. Crops



I. The Historical Database
Data Collection

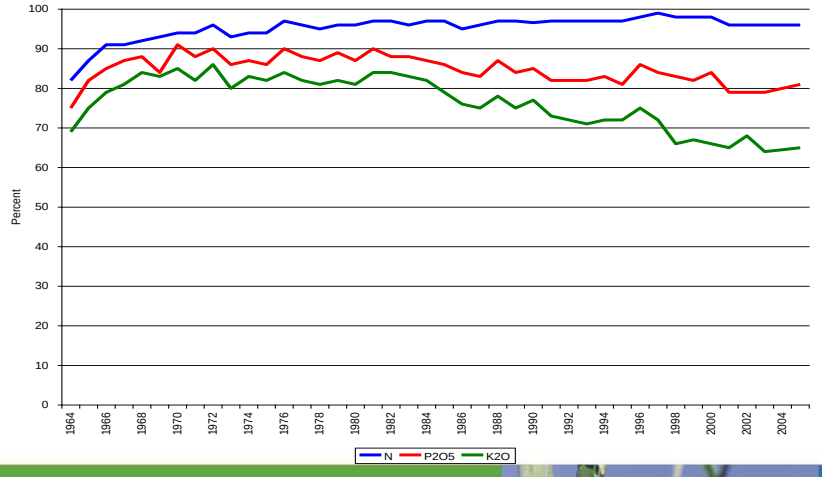
2. Percent of Planted Area Fertilized

- ***Identify area fertilized for each major crop***
- ***Express as % of planted area***

Potential problems

- ***Only part of the data are available***

U.S. - Percent of Corn Acres Treated by Nutrient



I. The Historical Database
Data Collection

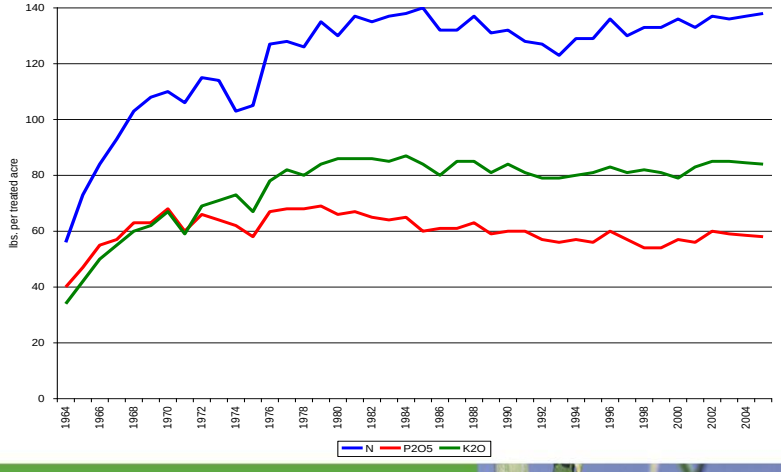
3. Average Application Rates (on treated area)

- ***Determine amount of each nutrient applied to crop***
- ***Express in kg/ha***

Potential problems

- ***Only part of the data are available***

U.S. - Application Rate per Treated Corn Acre



I. The Historical Database

Calculating Historical Nutrient Demand

Nutrient Effective Rate (for a given crop): the total quantity of fertilizer applied divided by the total planted area

Kg/ha → *Nutrient Effective Rate = (% of Crop Area with Nutrient Applied) X (Average Nutrient Application Rate)*

Kg/ha

Nutrient Consumption by Crop:

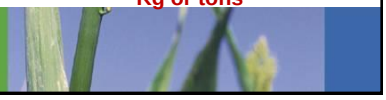
Nutrient Demand = (Nutrient Effective Rate) X (Planted Area)

Kg or tons — Kg/ha — Ha

Aggregate Nutrient Demand:

Total Nutrient Demand = Σ Nutrient Demand by Crop

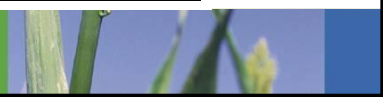
Kg or tons — Kg or tons



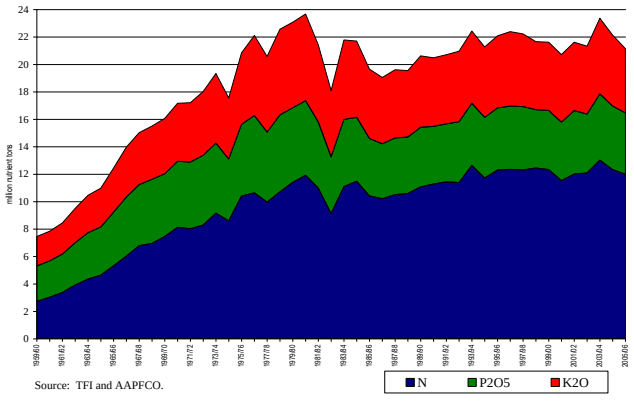
I. The Historical Database

Calculating Historical Nutrient Demand

	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



U.S. Fertilizer Nutrient Consumption 1959/60 – 2005/06



Source: TFI and AAPFCO.

I. The Historical Database
A Few Thoughts

After calculating historical nutrient demand, verify:

1. ***Historical estimates make sense***
   - ***Compare to***
     - ***Apparent consumption***
     - ***Recommended rates***
     - ***Independent estimates***

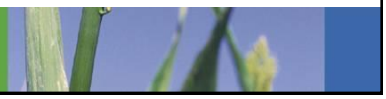
2. ***Estimates are defensible*** ***(i.e. changes in data can be explained)***
   - ***Triangulate data/sources***
   - ***Verify trends***

I. The Historical Database
Other Useful Data

One More Useful Data Set: Apparent Consumption

- *Gather Data on Production, Imports, and Exports by Fertilizer Product*
  - *Triangulate Data if Possible*
- *Calculate for each product (by nutrient content):*

  Apparent Consumption = (Production + Imports – Exports – Non-Fertilizer Use)
- *Sum Nutrient Totals*
- *Compare to Crop Based Forecast*



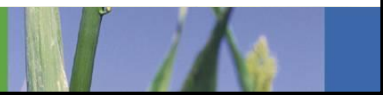
I. The Historical Database
Other Useful Data

Example: Apparent Consumption
Venezuela Nitrogen Consumption FY 2007

Nitrogen Fertilizers (000 tonnes N)

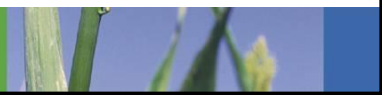
	Production	Imports	Exports	App. Cons.
Urea	668	4	501	171
AS	13	0	2	11
Comp	50	27	4	73
TOTAL	731	31	507	255

Compare this to the crop-based calculations
- *Allow for non-fertilizer use and stock change*



I. The Historical Database
Other Useful Data

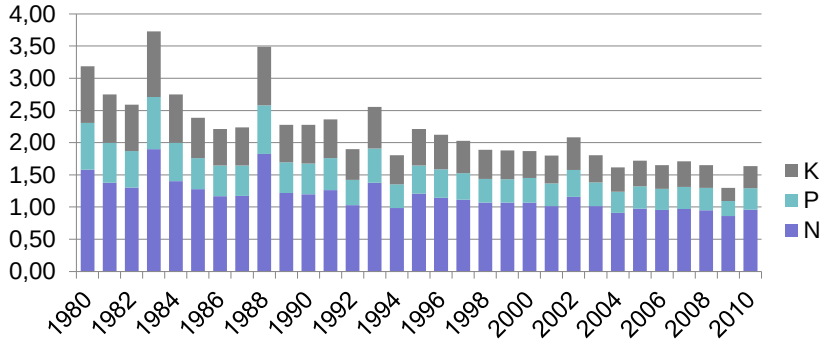
- ***Importance of Crop Yield Data***
- ***The ratio of Nutrient Use / Crop Production***
  - ***Identifies trends in application rates***
  - ***Identifies historical anomalies***
  - ***Allows additional fine-tuning of forecast***

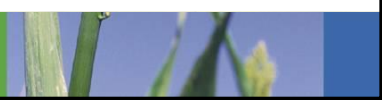


I. The Historical Database
A Few Thoughts

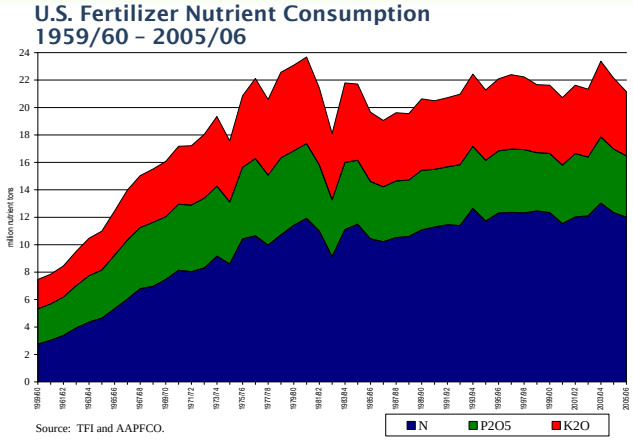
Importance of Crop Yield Data
The Nutrient Use to Crop Production Ratio

Example: U.S. Corn Nutrient Use (lb.) / Bushel Produced





Analysis of Factors driving Year-to-Year Changes in Fertilizer Use (1/4)



1960s and 1970s

- Rapid steady growth, infrequent declines

From the 1980s:

- Slower growth
- Frequent and large year-to-year changes

Analysis of Factors driving Year-to-Year Changes in Fertilizer Use (2/4)

✓ Start with what you know about the data:

- Major fertilizer nutrient using crops
- Factors which influence crop area
- Factors which influence % of treated area
- Factors which influence application rates

Analysis of Factors driving Year-to-Year Changes in Fertilizer Use (3/4)

What major factors drive year-to-year changes in nutrient use for your country?

Example: USA

=> Major Driver: Changes in planted crop acreage

=> Minor Driver: Changes in % area fertilized and application rates

But these can vary from year-to-year!

Analysis of Factors driving Year-to-Year Changes in Fertilizer Use (4/4)

What major factors drive these changes?

- ✓ Government Policies:
  1. Specific Fertilizer Policy (example: subsidy)
  2. Agricultural
  3. Trade
  4. Environmental
- ✓ Fertilizer Prices, Crop Prices and Their Ratio
- ✓ Crop Mix
- ✓ Agricultural Technology (Precision Ag, Biotech)
- ✓ Nutrient Recycling

II. The Qualitative Scenario

"What Will the Future Look Like?"

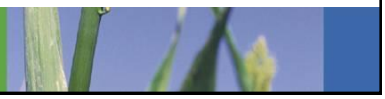
Develop assumptions about conditions that will impact crop acreage and nutrient application

Consider

- *Domestic and world economies*
- *Crop market conditions*
- *Fertilizer market conditions*
- *The regulatory environment*
- *Infrastructure investments or limitations*
- *Agronomic performances*

Avoid

- *Government/Industry targets*



II. The Qualitative Scenario

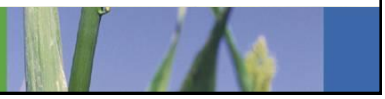
"What Will the Future Look Like?"

Domestic and World Economies

- *Population growth*
- *GDP and income*
- *Changes in per capita consumption*

Crop and Fertilizer Market Conditions

- *Domestic and world supply/demand/inventories*
- *Import/export conditions*
- *Expected prices and producer budgets*
  - *Crop/nutrient price ratios*



II. The Qualitative Scenario

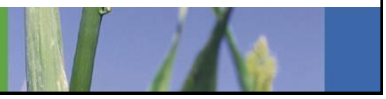
"What Will the Future Look Like?"

Regulatory Environment

- *Trade*
- *Agricultural*
- *Environmental*
- *Price Protections/Subsidies*
- *Energy Policies*

Infrastructure

- *Limitations to Growth*
- *Recent/Upcoming Investments*

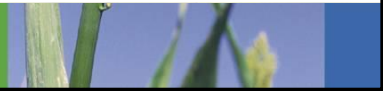


III. The Quantitative Forecast *Overview*

Using information and data from stages I and II, develop the Forecast

Two possible approaches:

1. *Forecast Year-By-Year*
   - *Begin with Base Year*
   - *Forecast Year 1*
   - *Forecast Year 2… etc.*
2. *Forecast in Five Year Increments*
   - *Begin With Base Year*
   - *Forecast Year 5*
   - *Interpolate Trend Over 5 Year Period*



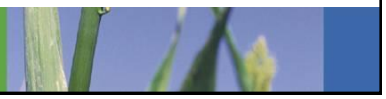
III. The Quantitative Forecast
Applying Your Qualitative Conditions

"For Each Crop, Consider Impact of Stage II Assumptions on Each Forecast Component":

Planted area is impacted by:

- *Crop prices*
- *Weather*
- *Government policies*
- *Changes in demand*
- *Infrastructure*

If growing regions differ substantially: forecast individually



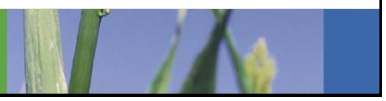
III. The Quantitative Forecast
Applying Your Qualitative Conditions

"For Each Crop, Consider Impact of Stage II Assumptions on Each Forecast Component":

The percent of area fertilized and the application rates are impacted by:

- *Crop prices and yields*
- *Fertilizer prices and availability*
- *Soil type, moisture, and weather*
- *Policy changes*

Historical data is key and can help to define trends



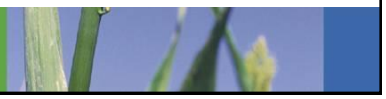
IV. Forecast Validation

Recall our Goal: "To Arrive at a Realistic, Objective, and Defensible Forecast"

The final step: verify that the forecast meets these criteria

1. ***Cross check results***
2. ***Seek out supporting data***
3. ***Compare to other methodologies***
   - ***Trend Forecast***
   - ***Growth Rate Forecast***

Once comfortable with the forecast, explain results.



Concluding Remarks

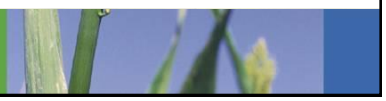
Recall our Goal: "To Arrive at a Realistic, Objective, and Defensible Forecast"

Maintaining your forecast

1. ***Update your stage II assumptions regularly***
2. ***Anticipate/explain structural changes***
   - ***Historical data***
   - ***Forecast***
3. ***Compare results with others***
4. ***Rely on and trust your own expertise***

Your forecast will improve over time

- ***Progressive increase of crop coverage***
- ***Progressive improvement of data quality***



In Summary

The Four Stages of the Crop-Based, Expert-Based Forecast

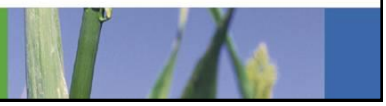
Our goal: "to arrive at a realistic, objective, and defensible forecast"

Main steps:

I. Create a historical database or 'base year'
II. Develop a qualitative scenario: outlook conditions
III. Prepare the quantitative forecast
IV. Validate the forecast

3 variables

1. Area planted to major crops
2. Percent of planted area fertilized by nutrient and crop type
3. Average application rates of nutrients by crop type



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