

# Market Mosaic

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## Volatility and Risk Management



*Market Mosaic is a quarterly newsletter published for our customers, suppliers and stakeholders by the Market Analysis group of The Mosaic Company. The spring and fall issues recap our assessment of the near term outlook for agricultural and crop nutrient markets. The summer and winter issues provide an in-depth look at topics of special interest to our readers.*

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**E**xtraordinary price volatility during the last few years has exposed the lack of traditional risk management tools in the crop nutrient industry. In this issue of Market Mosaic, we analyze recent price volatility and illustrate how manufacturers, distributors and farmers could use more powerful tools such as futures and swaps contracts to better manage risk in what likely will remain a volatile market environment.

We examined the volatility of six commodity prices including prices for the three primary crop nutrients as well as corn, oil and copper during the last decade. The analysis shows that prices for all six commodities trended upward and became more volatile throughout the decade. For example, current prices for these commodities are roughly two to three times their averages in 2000 – increases that explain the keen interest in the basic materials sectors.

Crop nutrient prices exhibited even greater volatility than the three other commodity prices during the past few years. However, just because crop nutrient prices are volatile doesn't mean that large price movements are not explainable. In fact, a statistical analysis of phosphate (P) and potash (K) prices reveals that changes in supply and demand drivers such as corn, energy and raw materials prices explained nearly all of the volatility in P&K prices during the past decade. The greater volatility of crop nutrient prices resulted from the fact that many of the key drivers also were highly variable during this period.

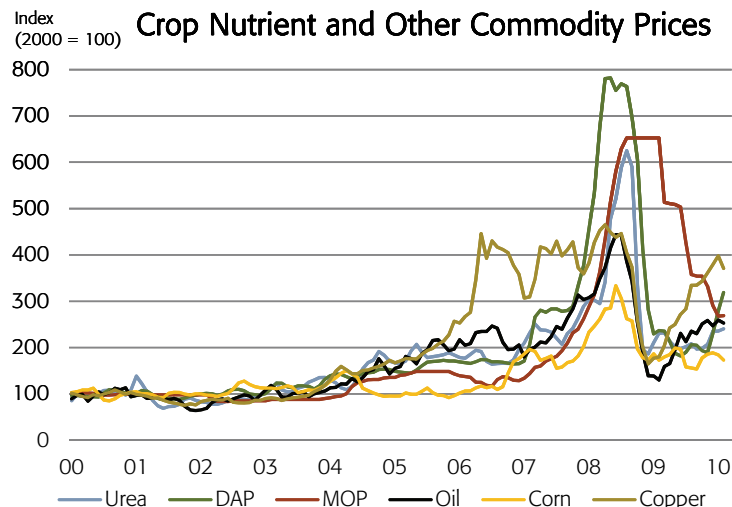
However, just because statistical models explained P&K price movements doesn't imply that these prices are predictable. Accurate price forecasts require accurate forecasts of supply and demand drivers – and many of these variables are highly volatile. As a consequence, crop nutrient prices are expected to stay volatile as long as key drivers remain highly variable.

The lack of more powerful risk management tools such as futures contracts and the limited use of swaps contracts manifests itself in less robust price discovery as well as inefficient supply chain operations. For example, distributors today are minimizing inventory valuation risk by making smaller and more frequent purchases, relying heavily on just-in-time inventory, entering into consignment arrangements with manufacturers and utilizing a variety of no-price-established (NPE) purchase contracts offered by some manufacturers. Such processes and programs are consequences of the extreme volatility of the past few years, but our assessment is that many of these are either not sustainable or not optimal over the long haul. We support the development of futures contracts and the greater use of existing swaps contracts in order to improve price discovery and risk management in this industry, but the impetus for the development and use of these tools needs to come from wholesale and retail distributors who have the need for a true hedging tool.

**– continued inside**

# Measuring Price Volatility

Everyone knows that crop nutrient and other commodity prices are volatile, but defining and measuring volatility is somewhat complex. However, much like Supreme Court Justice Potter Stewart's often-quoted 1964 opinion about the definition of pornography, we know volatility when we see it – and the chart below looks like volatility.



The chart plots price indices for three main crop nutrient products – urea, diammonium phosphate (DAP) and muriate of potash (MOP) – as well as for corn, oil and copper from the beginning of 2000 through February 2010. Prices spiked to Everest-like peaks around mid-2008 before plummeting during the financial crisis and Great Recession of 2008/09. Copper and oil prices began to increase before crop nutrient prices, but crop nutrient prices soared to higher levels than the three other commodity prices before collapsing during the downturn.

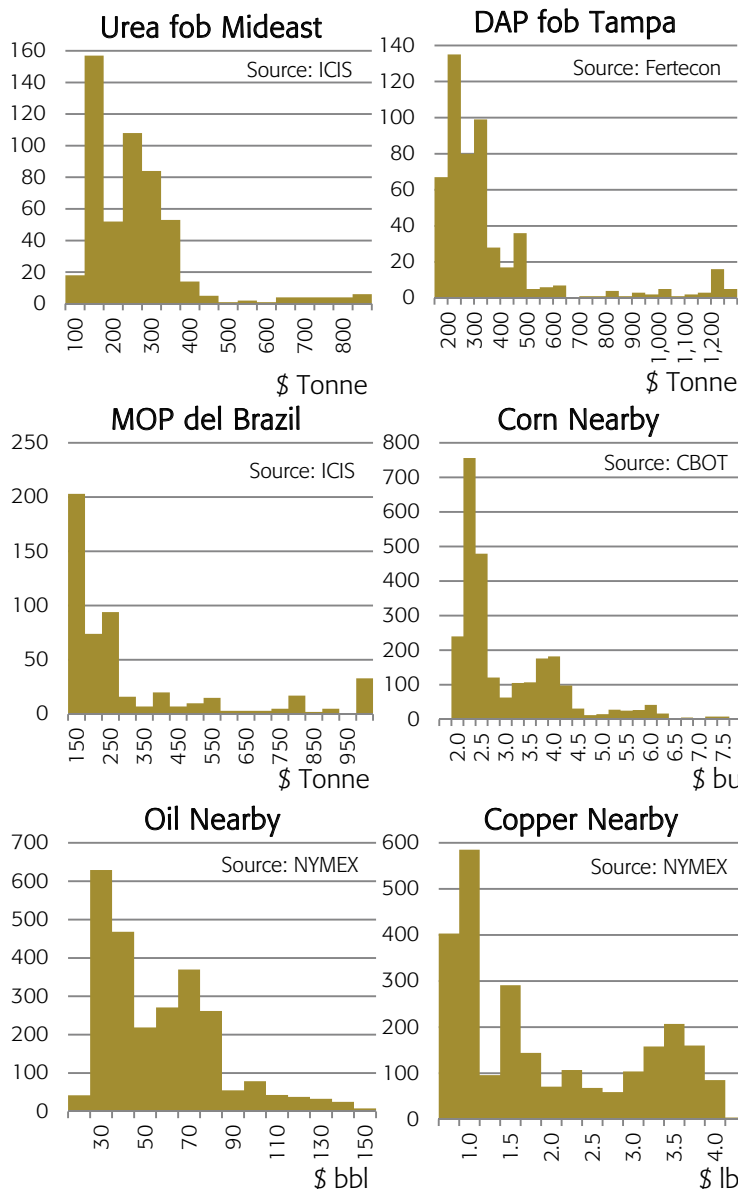
The chart looks like volatility, but there are statistics that quantify historical volatility. The coefficient of variation (CV) is a simple statistic often used to measure historical volatility. It is defined as the standard deviation divided by the mean (expressed as a percentage). Dividing the standard deviation by the mean is a way to standardize this measure in order to compare the volatility of different series.

The charts and tables show frequency distributions as well as summary statistics for each of these series since 2000. The tables reveal that the volatility of crop nutrient prices was similar to that of the other three commodities during the first half of the last decade. For example, the CV for the three crop nutrient prices ranged from 14% to 26% while the CV of the other three com-

## Commodity Price Frequency Distribution

Jan. 2000 - Feb. 2010

Frequency (Vertical Axis)



modities ranged from 13% to 25% from the beginning of 2000 through the end of 2004. Urea prices were the most volatile of the six commodities due in large part to the volatility of natural gas prices during the first half of the decade. Copper prices were only slightly less variable than urea prices and diammonium phosphate (DAP) and muriate of potash (MOP) prices were more volatile than corn prices but less volatile than oil prices during the first half of the last decade.

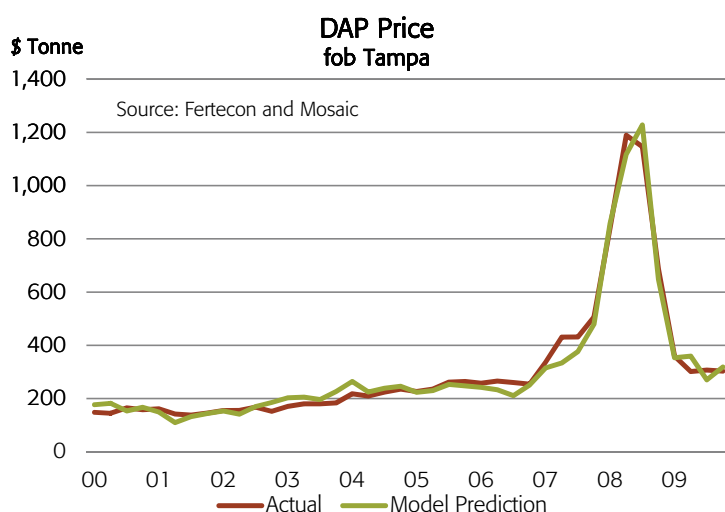
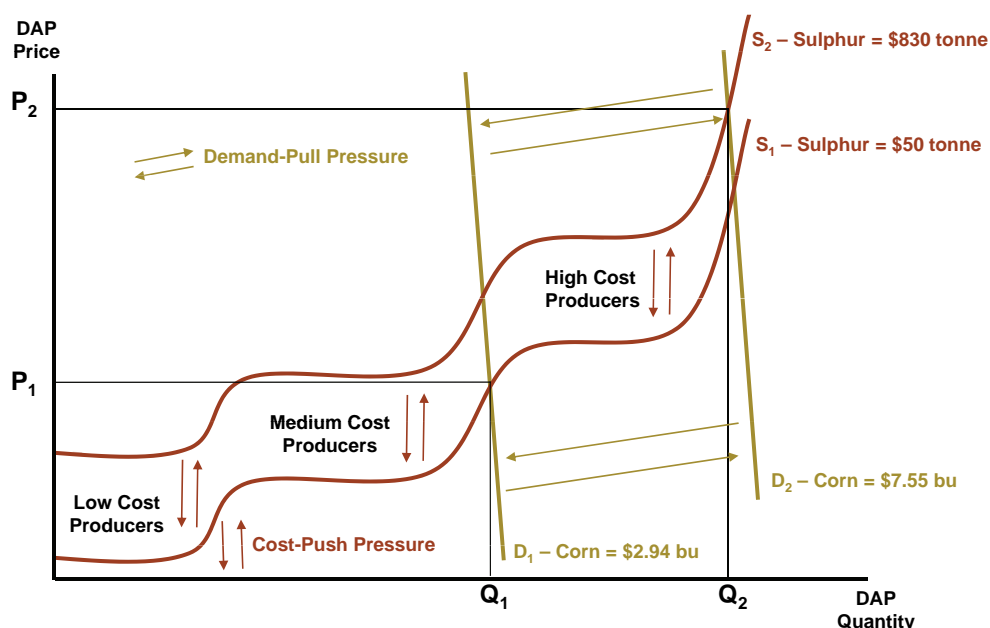
Crop nutrient prices, however, were more volatile than the other three commodity prices during the last half of this period. The CV for the three crop nutrient prices ranged from 44% to 66% while the CV of the other three commodities ranged from 30% to 35% during this period. Phosphate prices were the most volatile with a CV of 66% followed closely by potash with a CV of 65%.

*"Just because crop nutrient prices are volatile doesn't mean large price movements are not explainable. However, just because statistical models explain P&K price movements doesn't imply that these prices are predictable."*

- Dr. Michael Rahm

\$ Tonne	Urea fob Mideast		DAP fob Tampa		MOP del Brazil	
	2000-04	2005-10	2000-04	2005-10	2000-04	2005-10
Median	\$137	\$270	\$164	\$312	\$145	\$273
Mean	\$143	\$318	\$172	\$444	\$145	\$429
Standard Deviation	\$37	\$139	\$29	\$290	\$20	\$275
CV	26%	44%	17%	65%	14%	64%
Skewness	1.16	2.45	0.88	1.70	1.46	0.90
Minimum	\$90	\$213	\$133	\$222	\$124	\$173
Maximum	\$253	\$834	\$238	\$1,228	\$200	\$963

	CBOT Corn \$ bu Nearby		NYMEX Oil \$ bbl Nearby		NYMEX Copper \$ lb Nearby	
	2000-04	2005-10	2000-04	2005-10	2000-04	2005-10
Median	\$2.20	\$3.57	\$30	\$67	\$0.79	\$2.92
Mean	\$2.26	\$3.50	\$31	\$72	\$0.88	\$2.71
Standard Deviation	\$0.30	\$1.22	\$7	\$21	\$0.22	\$0.81
CV	13%	35%	22%	30%	26%	30%
Skewness	1.17	0.79	1.08	1.26	1.17	-0.26
Minimum	\$1.75	\$1.86	\$17	\$34	\$0.00	\$1.25
Maximum	\$3.31	\$7.55	\$55	\$145	\$1.54	\$4.08



## Root Causes

Crop nutrient prices are volatile for several reasons. The diagram illustrates how shifts in supply and demand can cause large changes in crop nutrient prices. For example, increases in grain and oilseed prices incent farmers to plant more area and intensify cropping practices. That in turn increases the demand for crop nutrients and pulls the demand curve to the right. Similarly, increases in energy or raw materials costs push up the cost structure of the industry and shift the supply curve to the left. Just the opposite occurs when crop prices or raw materials costs decline.

The diagram may look academic, but analysts use this theory as a guide to estimate supply and demand functions from historical data. In fact, changes in key supply and demand variables such as agricultural commodity prices, energy and raw materials costs, industry operating rates and producer inventories explained 98% of the variation in the price of DAP fob Tampa and 96% of the variation in the price of MOP delivered to Brazil during the last decade.

The chart plots the actual price of DAP and the model prediction based on values for supply and demand drivers during the last decade. Even the extremely volatile price movements of the last few years are explained by changes in supply and demand. For example, the nearby price of corn soared to \$7.55 per bushel at the close of trade on June 27, 2008 and then plunged to \$2.94 per bushel at the close on December 8, 2008. On the supply side, the price of sulphur delivered to non-integrated DAP producers in India spiked to more than \$830 per tonne in June 2008. Exactly one year

later, Indian buyers paid less than \$50 per tonne. The DAP price model indicates that the declines in corn prices and sulphur costs alone would cause the price of DAP fob Tampa to plunge almost \$650 per tonne!

Accurate forecasts of crop nutrient prices obviously require accurate forecasts for these important supply and demand drivers and, as the above example illustrates, many are highly volatile and difficult to predict. Scenario analysis is a useful forecasting tool in this situation. Scenarios are stories about future states of the world based on assumptions about social, political and economic developments and how they impact these drivers. In this context, the goal of forecasting is to develop plausible scenarios and handicapping them accurately. However, at the end of the day, manufacturers, distributors and farmers must place bets on scenarios that still are uncertain and require effective tools to manage price risk.

## Futures Markets

Futures contracts are one of the most widely used risk management tools in several commodity businesses including agriculture, energy and metals.

Futures markets perform two critical economic functions – price discovery and risk transfer – and two types of active participants – speculators and hedgers – are required for a viable futures market. Speculators have no cash market position. They simply trade futures contracts with the intent to make a profit by buying low and selling high in either order. However, the combined activities of speculators translate the vast and growing amounts of information about global supply and demand into a transparent and liquid market price.

Hedgers participate in the cash market but they also buy and sell futures contracts in order to transfer risk and reduce the impact of price volatility on their businesses. The term hedging connotes risk mitigation. Yet there is an important distinction between using futures contracts to forward price and using them to place a true hedge. We carefully distinguish between the two even though the terms hedgers and hedging are applied to both.

## Forward Pricing

Players at the two ends of the supply chain use futures contracts to forward price. For example, at one end a producer of a commodity can sell futures contracts in order to forward price cash sales that will be made at a later date. At the other end, an end user can buy futures contracts to forward price cash purchases that also will be made at a later date. In both cases the buyer and seller use the futures market transaction as a temporary substitute for a cash market transaction that will be made in the future.

In some industries futures markets exist for the output as well as the raw material and processors can forward price both to establish a margin. Classic examples include soybean processing and petroleum refining. A soybean processor who buys soybeans and crushes them into oil and meal can establish a board crush margin by selling soybean oil and meal contracts and buying a corresponding quantity of soybean contracts. Similarly, a petroleum refiner who buys oil and cracks the molecule into gasoline and other products can sell gasoline contracts and buy a corresponding quantity of oil contracts to establish a board gasoline crack margin.

Players at the two ends of the supply chain make either sell-only or buy-only transactions in the cash market. Forward pricing or even establishing a processing margin protects them against adverse price moves *from the level at which they fixed the price or margin*. That may achieve important risk management objectives such as the ability to service debt, meet key financial targets or secure financing for expansions. However, forward pricing or fixing a processing margin still is a bet that will turn out to be a winner or loser depending on how the market unfolds over time (see below).

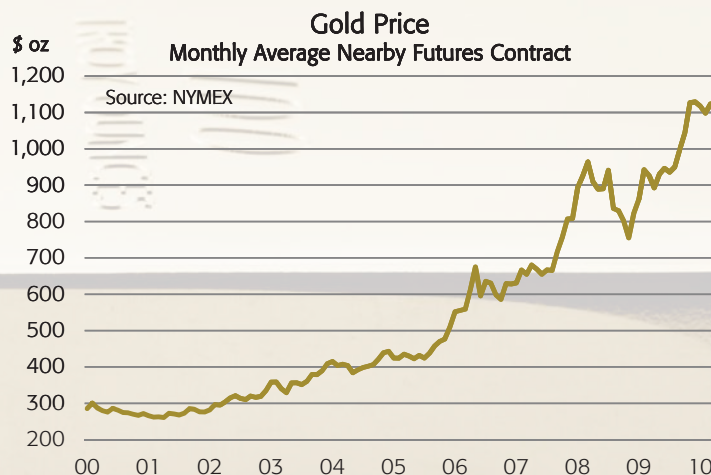
## Hedging

Futures contracts provide an effective day-to-day risk management tool for players between the two ends of the supply chain. These typically are wholesale and retail distributors who make buy-sell transactions in the cash market as they move a commodity through the supply chain. They are in the business of providing what economists call time, place and form utility. They may move a commodity into a warehouse and store it for several months until the next buyer wants to make a purchase or they may add value by conditioning or even upgrading the commodity. These operations are in business to earn returns on their brick-and-mortar investments as well as the services provided to buyers. They seek to transfer commodity price risk to others such as speculators or even hedgers who use futures markets to forward price or fix margins.

Futures contracts are a powerful tool to transfer and significantly reduce commodity price risk for such players. They execute a true hedge – defined as having equal and opposite priced positions in a cash and futures market. Take the case of a grain merchandiser. When a merchandiser buys corn from a local farmer, it will immediately sell a corresponding amount of futures contracts in the deferred month when it expects to sell the corn. When that time arrives, the merchandiser will sell the corn in the cash market and offset its position with the exchange clearinghouse by buying back futures contracts. The merchandiser is truly hedged in the sense that a gain or loss in its cash position will be largely offset by a corresponding loss or gain in its futures position. Risk

## Forward Pricing: Gold Industry Case Study

Gold producers often forward price this precious metal by selling futures or swap contracts. In fact, financial institutions sometimes require producers of gold or other metals to forward price output in order to obtain financing for new projects. Forward pricing is a profitable move in a declining market, but a costly strategy in a rising market. The chart shows that gold prices increased steadily during the last decade and that forward pricing was a costly strategy for the industry during this period. Barrick Gold, the world's largest gold miner, captured headlines last fall when it announced that it would buy back or lift its existing gold hedges for about \$2.9 billion due to the increasingly positive outlook for gold prices.



is not completely eliminated, however, because the basis – or difference between the local cash price and the futures price – may vary depending on local supply and demand conditions. However, basis risk is far less than flat price risk in most instances.

## ***Crop Nutrient Futures Contracts***

A grain merchandising company would not operate its business without a risk management tool such as futures contracts. Yet wholesale and retail crop input suppliers who make similar buy-sell transactions have seldom used them.

Futures contracts for several crop nutrient products were developed and launched by leading exchanges on two separate occasions during the last 20 years. The Chicago Board of Trade (CBOT) began trading DAP and anhydrous ammonia contracts in the fall of 1991. Volume and open interest for nearly the first two years of trading were respectable for a new contract. Interest from both speculators and hedgers, however, waned after market makers withdrew and the CBOT eventually de-listed both contracts in July 1997.

The Chicago Mercantile Exchange (CME) developed urea, urea ammonium nitrate solution and DAP contracts several years later. The CME listed them on their Globex Electronic Trading Platform on June 6, 2004. Again, the contracts garnered moderate interest at the start of trading but then volume and open interest declined. The CME de-listed the contracts in September 2007.

Our post mortem for crop nutrient futures contracts is not much different from those for numerous other futures contracts that have failed over time. A viable futures contract requires the support and widespread participation of both speculators and industry hedgers. Each group has to have confidence and trust that the other is engaged and playing the game. Speculators have to believe that hedgers are going to be there day in and day out to lay off risk. Hedgers have to believe that speculators are going to actively trade the contract in order to provide the liquidity required to forward price or hedge large volumes of these products. That confidence and trust simply did not develop in either launch.

# ***Commodity Futures Markets 101***

## ***Futures Contracts and Trading***

A futures contract is a legally binding agreement to make or take delivery of a commodity. The contract specifies the quantity and quality of the commodity as well as when and where the seller must make delivery. Price is the only contract parameter that is agreed to in a trade.

The trading of futures contracts traditionally has taken place on major exchanges through a system of open outcry by traders in pits designated for specific commodities. However, the development of sophisticated electronic trading systems in some cases has replaced and in other cases has supplemented traditional open outcry trading of futures contracts.

The seller of a futures contract agrees to make delivery and the buyer agrees to take delivery of the commodity. However, the counterparty to each side of a trade is an exchange clearinghouse rather than the opposite party of a particular trade. As a result, a seller of a single contract is short one contract with the clearinghouse. A seller can clear this position by either offsetting it by buying a contract or making delivery per contract specifications. Only a small percentage of short positions are ever delivered and delivery takes place only if it is economically more advantageous for the seller to deliver rather than offset the short position. Shorts declare their intent to deliver by filing a Notice of Intention to Deliver on the intention date spelled out in the contract.

A buyer of a futures contract is long one contract with the clearinghouse and can offset this position by selling a contract. After shorts declare their intent to deliver, the clearinghouse will line up long positions – usually by age – in order to determine who will get delivery. Delivery takes the form of a warehouse re-

ceipt from a delivery point specified in the contract and not the popular misconception of a line-up of semi-trailer trucks ready to dump soybeans in a forgetful long's front lawn.

## ***Margins and Margin Calls***

Buyers and sellers, typically working through a brokerage house, are required to deposit a margin in a clearinghouse account equal to a small fraction of the contract value in order to execute a trade. The margin, typically about 10% of the contract value, is best thought of as earnest money to insure performance. The clearinghouse settles all accounts at the end of the trading day, crediting gains and debiting losses based on the settlement price for all contracts that day. This illustrates the fact that futures markets are zero-sum games, meaning that for every dollar gain (or credit) there is a corresponding dollar loss (or debit). Trading volume simply is the number of contracts that trade during a day and open interest is the sum of long and short positions at the end of the trading day.

Buyers and sellers must maintain a minimum balance or call margin that usually is equal to a high percentage of the initial margin. If the clearinghouse account balance drops below the call margin, additional funds must be deposited into the account in order to bring the balance back up to the initial margin. Such margin calls can be significant given the recent volatility in many commodity prices and trading leverage (e.g. a \$1 margin controls a quantity of a commodity initially worth about \$10). In fact, during the sharp run-up in commodity prices in 2008, many short hedgers – including even the largest players – exhausted lines of credit due to unprecedented margin calls and were forced to liquidate positions or curtail cash market activities.

## Crop Nutrient Swaps Contracts

Swaps contracts are another powerful risk management tool. Two brokerage houses, Freight Investor Services (FIS) and Direct Hedge currently offer swaps contracts for several of the most widely used nitrogen and phosphate products. Like a futures contract, a buyer and seller agree on a price for a fixed quantity of a product at a future date. Unlike futures contracts, however, a typical swaps contract requires no initial margin and no delivery of a commodity. The contract is settled in cash at the time of expiration based on a specific price index.

Until recently, counterparty risk kept many potential buyers and sellers on the sidelines. For example, assume on November 1, 2009 Party A agreed to buy and Party B agreed to sell swaps contracts for 5,000 tonnes of DAP at the Tampa export price of \$300 per tonne in March 2010. If the price index used to settle this swaps contract increased to \$500 per tonne in March, then Party B would write a check to Party A for \$1,000,000 on the settlement date in March. Counterparty risk for Party A resides with Party B.

A breakthrough in the crop nutrient swaps market occurred last fall when FIS and LCH.Clearnet Ltd. launched an over-the-counter (OTC) clearinghouse service for four of the most widely traded swap contracts. Like an exchange clearinghouse for futures contracts, the OTC clearinghouse serves as the counterparty to each swaps transaction. This eliminates counterparty risk, keeps participation anonymous and guarantees timely contract settlements. However, the clearinghouse requires both initial and variation margins in order to insure performance of participants. The clearinghouse marks to market open positions each day and assesses the value at risk of a participant's net position in order to determine variation margin requirements.

FIS indicates that swaps volume totaled more than 3.0 million tonnes in 2009, accounting for about 8% of the physical trade in the relevant products. Swaps contracts based on U.S. settlement prices in New Orleans and Tampa accounted for about two-thirds of total volume. Urea and nitrogen solution swaps were the most widely traded contracts. FIS reports that volume and participation have increased significantly during the volatile market of the last two years. Although most swaps contracts

have settlement dates less than six months out, FIS also reports growing interest in contracts for 2011 and beyond.

## Lack of Industry Interest

Despite efforts to develop viable futures and swaps contracts during the last two decades, the crop nutrient industry has not embraced and fully utilized these tools. There are several hypotheses for the industry's lack of interest in more powerful risk management tools, particularly from wholesale and retail distributors.

First, some participants may be more risk-loving than risk-averse. Many long time and successful trading and distribution companies have consistently 'bought low and sold high' more than they have 'bought high and sold low' in cash markets over the long haul. They may not want risk management tools.

Second, retail dealers typically price crop nutrients on a cost-plus basis and may be able to pass price volatility on to the end user. This sales strategy may limit risk as long as all retailers serving a local market position product at about the same price and volatility isn't so extreme that it pulls in lower cost supplies from more distant sources. Recent statistics from the 2009 CropLife 100 – a survey of the top 100 retail dealers in the United States – showed a surprisingly small drop in total retail sales last year despite sharp declines in wholesale crop nutrient prices as well as nutrient use. The survey indicated that crop nutrient sales revenue declined just 3% to \$9.2 billion in 2009 from a record \$9.5 billion in 2008.

Lastly, in response to the extreme volatility of the past few years, many wholesale and retail distributors are shifting as much price risk as possible back to the manufacturer. Many distributors are making smaller and more frequent purchases, relying on just-in-time inventory, entering into consignment arrangements with the manufacturer and utilizing no-price-established (NPE) contracts offered by some manufacturers to limit inventory valuation risk. An analysis of the failure of the CBOT DAP contract by University of Illinois economists concluded, among other things, that industry participants perceived that the contract offered no benefits beyond existing contracting and risk management practices. In other words, why buy the cow when the milk is free?



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