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AGRICULTURE SECTOR



**SP Angel acts as
Financial Adviser and
Broker to ESV and
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**Please refer to the
disclosures on page 42**

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MAKE HAY (EVEN WHILE THE SUN DOESN'T SHINE)

- It may be that the most bullish “commodity super-cycle” price forecasts have been shelved for the time being
- But a generation of under-investment in agriculture means that crop prices should continue to reflect “peak grain” new entry costs for at least another decade
- This should allow the lowest cost agri producers with access to working capital to make exceptional returns with high visibility into the medium term

Commodity prices, including agricultural, have suffered over recent months as the increasing acknowledgment of a global economic slowdown has led to concerns over on-going demand levels.

We have lowered our near-term demand growth forecasts in SP Angel's Agricultural Commodity Model, but we estimate that even on our more prudent scenario there is very significant investment required in the industry if supply is to meet demand and future price shocks are to be avoided.

In particular we calculate that:

- The global agricultural reserve margin (stocks-to-use level) has fallen to the critical 15% level, which leaves the adequate supply of produce extremely vulnerable to a difficult weather year;
- To return to a healthy, and long-term average, reserve margin of 25% over the next 15 years will require the habilitation (or rehabilitation) of around 140m hectares (10% of total current arable land); and
- This last point, in conjunction with associated infrastructure needs in storage and transport, implies global investment requirements of the order of US\$230bn over the next 15 years.

We believe that the scale of the investment required, at a time of scarce and expensive capital, will combine with other high start-up costs and transport bottlenecks to keep agricultural commodity prices relatively high into the medium term. Specifically, we estimate that the price of grain and oilseed will be set by new entry costs for at least another decade, and that the new entry cost of wheat is currently US\$226/ton and of soybean is US\$340/ton.

Our conclusions to this analysis are twofold:

- there should be very attractive margins to be made for lowest cost producers with access to adequately priced working capital; and,
- while this fact has been efficiently priced into land values in most parts of the agricultural world, this is not yet the case in Russia or Ukraine, where our model shows quality arable land should be valued at approx US\$3,500/Hectare compared to current market prices of c US\$1,500

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1. Executive Summary

A number of industry commentators have been calling an end to the “commodity super-cycle” paradigm, as prices for most globally-traded commodities (including agricultural) have tumbled over recent months. The argument is that a combination of supply side investment in recent years and falling global growth forecasts have helped to puncture what was in effect a commodity price bubble.

It is our contention, however, that the world of agriculture has not seen the same levels of investment in new capacity and transport as, for example, mining, in the last couple of years, and that, on the demand side, agriculture is structurally more resilient.

So even as we have lowered our near-term demand growth forecasts in S P Angel’s Agricultural Commodity Model to levels below those registered recently, we still estimate that there is very significant investment required in the industry if supply is to meet demand and future price shocks are to be avoided.

In particular we note that:

- A whole generation of under-investment in the industry has taken the global agricultural reserve margin (stocks-to-use level) to its lowest level in over 30 years. Indeed, even the explosion in prices seen in the last 2 years has barely stimulated a wave of new investment (other than, to a certain extent, in the “hot” biofuels sub-sector), and stocks-to-use more generally have fallen to the critical 15% level. This leaves the adequate supply of produce extremely vulnerable to a difficult weather year.
- The long-term average agricultural reserve margin of 25% is generally seen by industry players as being healthy and bringing supply and demand into more sustainable balance. We calculate that in order to reach this level over the next 15 years will require the habilitation (or rehabilitation) of around 140m hectares globally, even assuming 1.5% pa yield efficiency gains.
- In order to achieve this target over a 15 year timeframe - with everything it implies in terms of the habilitation of land, and the associated infrastructure needs in storage and transport - we estimate that global agricultural investment will need to be of the order of US\$230bn, or US\$15bn per annum.

The inherent difficulties associated with achieving this target are exacerbated because the ability of the supply side to respond is currently highly constrained. On-going technological innovation means that there is some scope for crop yields to keep rising around the world, but the problem really lies in the scale of the investment required, at a time of scarce and expensive capital.

On the basis, therefore, of a constrained supply side, in conjunction with other high start-up costs and transport bottlenecks, we estimate that

agricultural commodity prices will remain relatively high into the medium term. Specifically, we estimate that the price of grain and oilseed will be set by new entry costs in relatively expensive geographies (“peak grain”) for at least another decade, and that the new entry cost of wheat is currently US\$226/ton and of soybean is US\$340/ton.

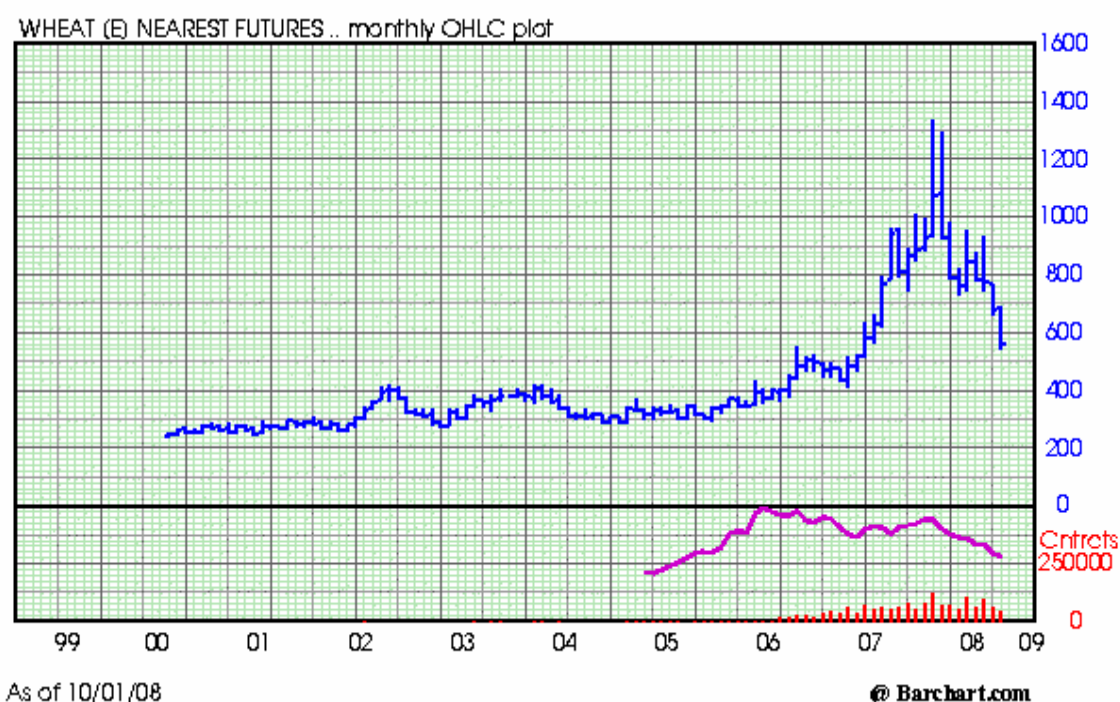
Our conclusions to this analysis are twofold:

- Firstly, there should be very attractive margins to be made for at least another decade for lowest cost incumbent producers with access to adequately priced working capital.
- Secondly, while this fact has been efficiently priced into land values in many parts of the agricultural world, this is not yet the case in Russia or Ukraine, where our model shows quality arable land should be valued at approx US\$3,500/Hectare compared to current market prices of around US\$1,500/Ha.

1.1 The end of the commodity “super-cycle” paradigm?

The chart below demonstrates, using the example of wheat, the extraordinary price volatility affecting agricultural commodities over the past two years.

Wheat price chart 2000-08 (USc/bushel)



Following a period of relative stability for the first 6 years of the decade, the price of wheat effectively then trebled over an 18 month period.

Commentators at the time were talking about a significant structural shift for globally traded commodities towards a “super-cycle”, meaning high prices for

much longer than in a traditional cycle, reflecting in particular the growth in demand from fast developing nations and the difficulties experienced by the supply side in playing catch up.

In the case of agriculture, the theme seemed even more convincing because of the impact of the new market in biofuels, with oilseed crops cannibalising tracts of land previously used to meet traditional demand.

However the chart above also shows how wheat prices have halved over the past 10 months, prompting a rethinking and even abandonment of the “super-cycle” paradigm. The argument being that growth expectations in the developing world, and China in particular, were exaggerated, and that the global credit crisis has led to a significant ratcheting down of global growth and demand forecasts.

We draw attention, in this research note, to the fact that agricultural prices, as seen in the above chart, are still at twice the levels they were in 2005, and that this reflects the fact that:

- the supply-demand balance is lot tighter than in other commodity markets;
- demand in the sector is resilient (notwithstanding lower growth rates in China); and
- levels of investment in agriculture over the past 3 years have barely responded so far to this higher priced environment.

1.2 Agricultural demand should be resilient...

We believe that the base case demand forecasts in our S P Angel Agricultural Commodity Model are prudent, responding to the potential impact of a global economic slowdown, yet reflecting also the resilient and defensive nature of this sector.

So for the 15-year period of our analysis (2008-23), with population growth predicted at 0.9% pa, we see a decrease in the growth of meat demand (2.0% pa versus 2.6% in 1993-2008), offset by an increase in cereal demand growth (2.0% pa versus 1.3% in 1993-2008), with corn demand being a big driver. Significantly, we take a prudent view on oilseed demand growth (3.5% pa versus 4.2% in 1993-08).

The table below summarises our demand forecasts, and puts them in the context of previous 15-year periods.

Agricultural commodity demand growth statistics and forecasts 1993-2023

	Av. pa 1961-76	Av. pa 1977-91	Av. pa 1993-2008	Total 1993-2008	Av. pa 2008-23	Total 2008-23
Population growth	2.0%	1.7%	1.4%	22.8%	0.9%	14.4%
Meat consumption growth	3.5%	3.0%	2.6%	47%	2.0%	34.6%
Cereal consumption growth	3.5%	1.8%	1.3%	21.4%	2.0%	34.6%
Oilseed consumption growth	2.9%	4.8%	4.2%	85.4%	3.5%	67.5%

Source: FAO; SP Angel estimates

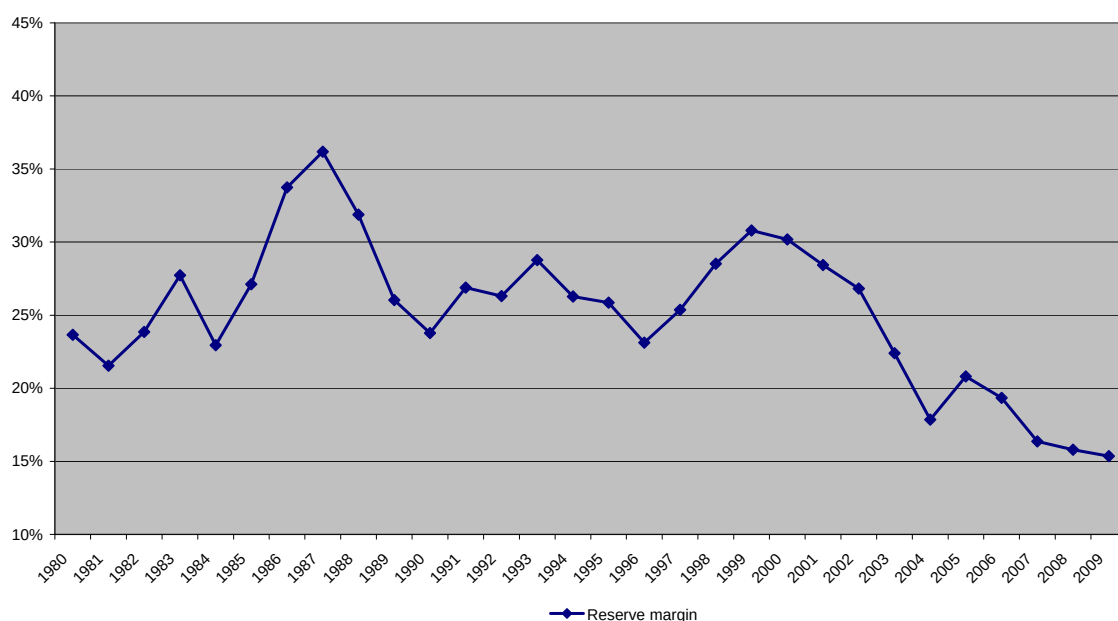
1.3 ...and investment to date has been limited

An interesting point, which sets agriculture apart from other commodity sectors (such as mining), is that the industry has been slow to respond to the last 3 years of high prices in terms of investing heavily in new supply.

The agricultural arable land bank, which stands currently at 1.4bn Ha, has hardly increased over this period (indeed it has hardly moved in 20 years), and even while crop yields have increased somewhat, demand growth has been such that stocks-to-use levels (or reserve margins) have collapsed. This means that recent annual crop growth has not met global supply, and, in every one of the last 5 years, previous years' stocks have been needed to meet demand.

The chart below demonstrates this trend for the aggregate of wheat and all coarse grains (which together represent over half of all arable produce by weight). Reserve margins are seen to reach levels not seen in the last 30 years.

Wheat and coarse grain global reserve margin 1980-2009



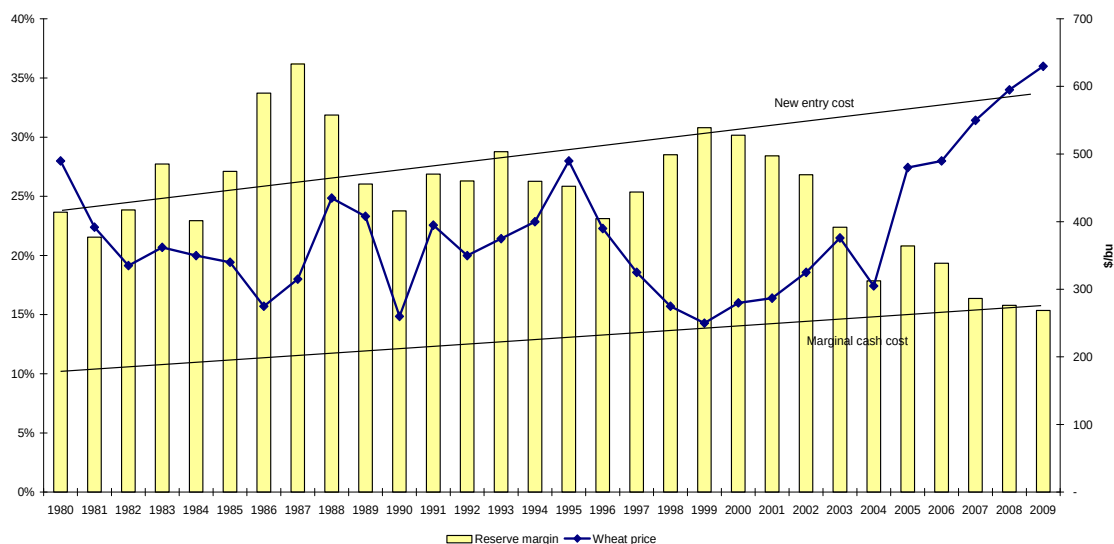
Source: USDA; SP Angel estimates

Agriculture has indeed suffered from a generation of under-investment, and even the recent price spikes have not yet been fully reflected in levels of new investment.

Commodity pricing theory dictates that when reserve margins fall below a certain level, prices start to soar through new entry cost levels (i.e. the price at which the full cost of capital can be recouped by a new entrant) until they reach a level at which new investment cannot fail to materialise.

The chart below shows, using the example of wheat, how the price has tended to fluctuate within a range between marginal cash cost and new entry cost, until 2008, when the expectation of reserve margins sticking to or below the 15% level have driven prices well above new entry costs.

Wheat prices, reserve margin and cost estimates 1980-2009



Source: SP Angel estimates; FAO; USDA

If this situation remains the same for some time to come, it is very difficult to see how capital will fail to flood into this market. But how long will it take for new investment to have a serious impact on prices?

1.4 It could take a decade for reserve margins to start growing

Our agricultural pricing model assumes that the demand growth forecasts outlined above are met by a combination of increasing crop yields (at a rate of +1.5% pa, in line with historical precedent), and investment in new land. The table below summarises what is required, for an aggregate of wheat, corn, soybean and rapeseed, to bring global reserve margins back to a sustainable 25%.

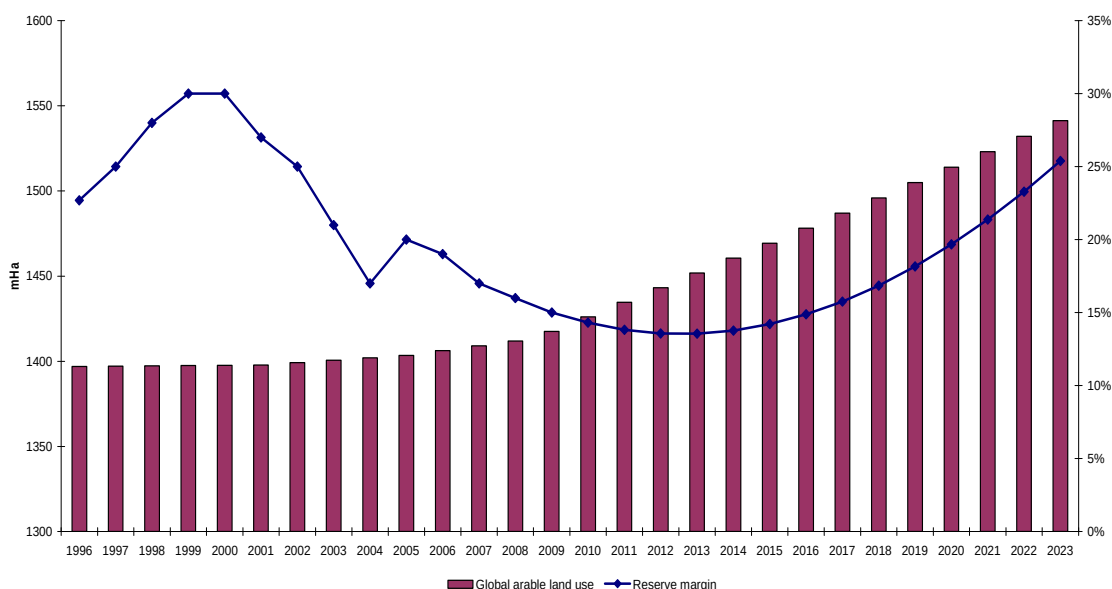
Four crop aggregate: S P Angel supply response forecasts (2008-2023)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Demand (mt)	2740	2816	2877	2939	3002	3067	3134	3201	3271	3342	3414	3488	3564	3642	3721	3802
% increase		2.8%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Production (mt)	2740	2798	2865	2933	3004	3076	3149	3225	3302	3382	3463	3546	3632	3719	3809	3901
% increase		2.1%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Yr start stock (mt)	443	442	424	412	406	407	416	431	455	487	527	575	633	701	779	867
% increase		-0.2%	-4.2%	-2.8%	-1.4%	0.3%	2.0%	3.8%	5.4%	6.9%	8.2%	9.3%	10.1%	10.7%	11.1%	11.3%
Total supply (mt)	3183	3240	3289	3345	3410	3483	3565	3656	3757	3868	3990	4122	4265	4421	4588	4768
% increase		1.8%	1.5%	1.7%	1.9%	2.1%	2.4%	2.6%	2.8%	3.0%	3.1%	3.3%	3.5%	3.6%	3.8%	3.9%
Reserve margin	16%	15%	14%	14%	14%	14%	14%	14%	15%	16%	17%	18%	20%	21%	23%	25%
Yield (t/Ha)	3.4	3.4	3.5	3.5	3.6	3.6	3.7	3.7	3.8	3.8	3.9	3.9	4.0	4.0	4.1	4.2
% increase		0.8%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%
Land use (mHa)	812	823	830	838	846	854	861	869	878	886	894	903	911	920	929	937
% increase		1.3%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%

Source: SP Angel estimates; USDA; FAO

The table above shows that if investment in new land occurs evenly through the period, it will be a full decade before reserve margins start to move meaningfully above the critical 15% level. This is demonstrated graphically below; the point is that under-investment (and disinvestment) has been such that supply will continue to dip into previous years' stocks to meet demand for another 6 years.

S P Angel global arable land area (all crops) and reserve margin estimates 1996-2023



Source: SP Angel estimates; USDA; FAO

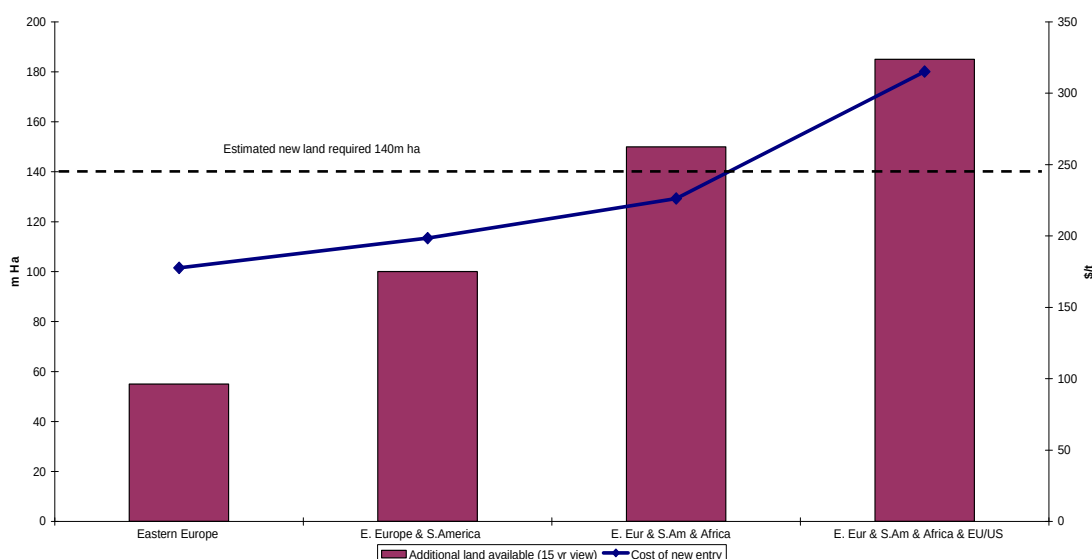
It is interesting to note, extrapolating from the above data into all agricultural crops, that in order to bring reserve margins (stocks-to-use) from 15% to 25% over the next 15 years would imply the habilitation, or re-habilitation, of 140m Hectares of new land. In this note, we will show that this could require some US\$230bn new investment (\$15bn pa) into the sector.

1.5 So prices could reflect new entry costs for another decade

Given that we forecast reserve margins at around the vulnerable 15% mark for another 10 years, it follows that prices should remain at levels which continue to incentivise new entry for the entirety of this period. Clearly with stocks-to-use levels so low, it wouldn't take much in terms of demand shock (global growth rebounding; biofuel use increasing), or supply shock (unusual weather; poor harvests), to send prices significantly above new entry levels.

In our calculation of new entry costs (or "peak grain" costs), we estimate that Sub-Saharan Africa will continue, as now, be the marginal player in the global market (ie where the most expensive bushel is produced to help meet global demand). The chart below shows the intersection between the 140m Hectares of new agricultural land required, the marginal geography needed on stream to meet that target, and the cost of so-doing.

S P Angel estimate of marginal geographies and the cost of new entry



Source: SP Angel estimates; USDA; FAO

Based on current agricultural cost dynamics, we calculate in this research note that the cost of new entry for wheat in Sub-Saharan Africa averages out at US\$226/tonne, which is very much in line with current forward market prices as registered on the Chicago Board of Trade.

We summarise below our average new entry cost estimates for the 4 crop types in this study, across the 4 key geographies of Eastern Europe, South America; Sub-Saharan Africa; and the US/EU axis.

Summary S P Angel cost of new entry estimates for wheat, corn, soybean and rapeseed \$/t

	Eastern Europe	South America	Sub-Saharan Africa	US/EU
Wheat	178	198	226	315
Corn	138	154	176	245
Soybean	267	298	340	473
Rapeseed	345	385	439	612

Source: SP Angel estimates

It is interesting to note that market prices currently approximate most closely to “peak grain” levels, i.e. the new entrant level of our estimate of the marginal geography in the market, Sub-Saharan Africa. It would not be surprising to us, however, in the case of a demand or supply shock, that the market price move up to the higher new entrant costs of the developed world (US and EU).

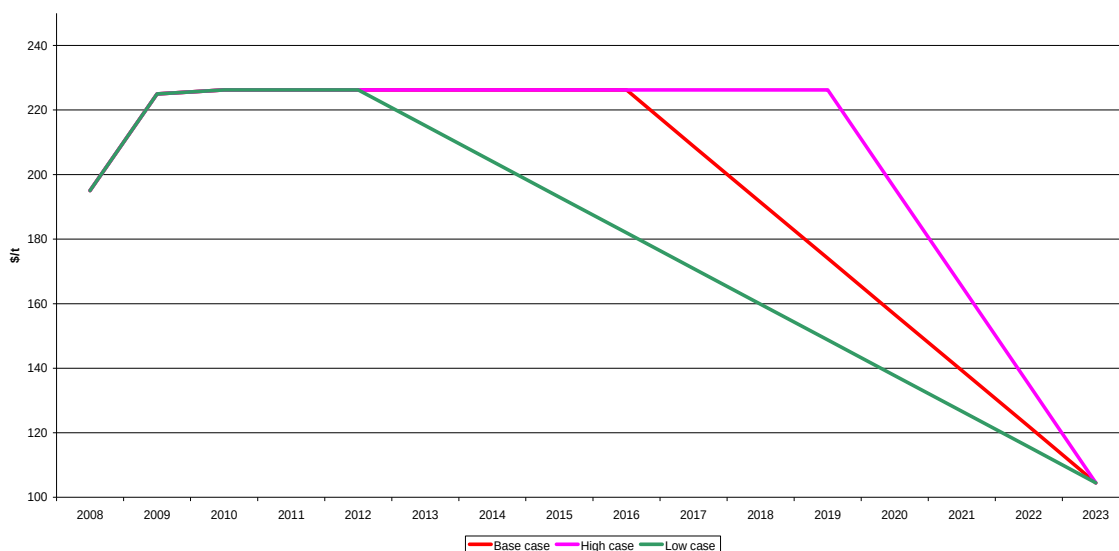
1.6 Even our bear case scenarios offer high margins

Given how tight agricultural reserve margins are currently, it is difficult to see how prices could fall much below new entrant costs in the near term (although of course a bumper harvest can have a short term impact on prices).

We have developed three price profile scenarios as the key sensitivity for our valuations. Each scenario takes the current forward price curve for the next 2 years, and each prudently sees a collapse of prices to marginal cash costs by 2023. But whereas our mid-case scenario sees prices stable at the new entry cost level until 2016, the bull case sees that resilience until 2019, and the bear case until only 2012.

The graph below maps out each of these scenarios.

S P Angel wheat price forecast scenarios 2008-2023 (\$/t)



Source SP Angel estimates

Our sense is that risk is skewed to the upside in this model – i.e. that the downside is structurally fairly limited given the industry dynamics currently, but that the upside is substantial, if it turns out we have been overly prudent on demand growth assumptions, or if recent unusual weather patterns turn out to be normal rather than freak.

1.7 Valuations are attractive if you look in the right places

So how does this analysis and these forecasts help us from an investment point of view? In order to answer this, we need to calculate, of course, the extent to which our conclusions on prices are already discounted in land and company valuations.

The table below summarises the valuations implied for land and agricultural businesses by our price forecasts. Full details of the discounted cash flow

methodology behind these multiples are provided in Section 6 of this research note.

Summary S P Angel base case valuations for arable farming across 4 geographies (\$)

	EV/Ha	EV/t	EV/Ebitda
US/EU	9690	1292	9.6
Eastern Europe	3509	702	6.4
South America	3248	650	6.1
Sub-Saharan Africa	1802	451	5.0

Source SP Angel estimates

With their lower cost of capital, valuations are clearly higher for land and businesses in North America and the EU than in the other large centres for arable farming, Eastern Europe and South America (note that these are *average* valuations across large geographies and that valuations will vary significantly within those areas, but they do serve as an interesting starting point to appraise the spread of valuations globally).

However, when we look at average current land values across those geographies, it appears to us that whereas land and agri-businesses in the developed world and in South America are already largely discounting our view of prices and costs over the coming 15 years, those in Eastern Europe (we focus on Russia and Ukraine) seemingly do not. This is apparent in the table below.

S.P.Angel agricultural land valuations compared to actual current land values \$/ha

SPAngel valuation		Current land values	
US/EU	9690	US	8000
		UK	18000
Eastern Europe	3509	Russia	1000
		Ukraine	1500
South America	3248	Brazil	3400
Sub-Saharan Africa	1802	Mozambique	1100

Source SP Angel estimates

Our analysis, which we believe forms an essential framework from which to drill down into sub-regions and individual businesses, shows that those agricultural land banks which can deliver decent yields at relatively low cost, and where working capital is already in place, will be able to achieve very high returns in the current high-priced environment. Within this context, the best value for investors currently appears to be found in Eastern Europe, and in particular, the rich soils of Russia and Ukraine.

2. The agricultural commodity cycle and the scope of this report

2.1 Report objectives and methodology

In this report we show how agricultural economics follow the typical cyclical patterns of other freely traded commodities, but with some interesting idiosyncracies. We show how the shifting balance between supply and demand has impacted on prices and from there to investment and disinvestment decisions, over the past 30 years. From there we develop a framework for forecasting prices over the next 15 years. This in turn will provide a powerful model for valuing land and indicating the potential levels of investment and returns which could characterise this sector going forward.

Our preliminary objectives are as follows:

- To determine whether the sector has become an investible proposition once more; i.e. has pricing reached levels at which equity investors can project positive margins with significant visibility on a 10 to 15 year timescale?
- To determine whether some geographies are more investible than others. While output prices and some input prices are globally determined, there is wide variability in production costs depending on the geographies and business models observed. In this context, where are the lowest cost producers?
- To determine the levels of return achievable from agriculture, given our price forecast scenarios. What equity returns can investors expect once they have identified the most attractive businesses?

2.2 Choosing crop types and timescales

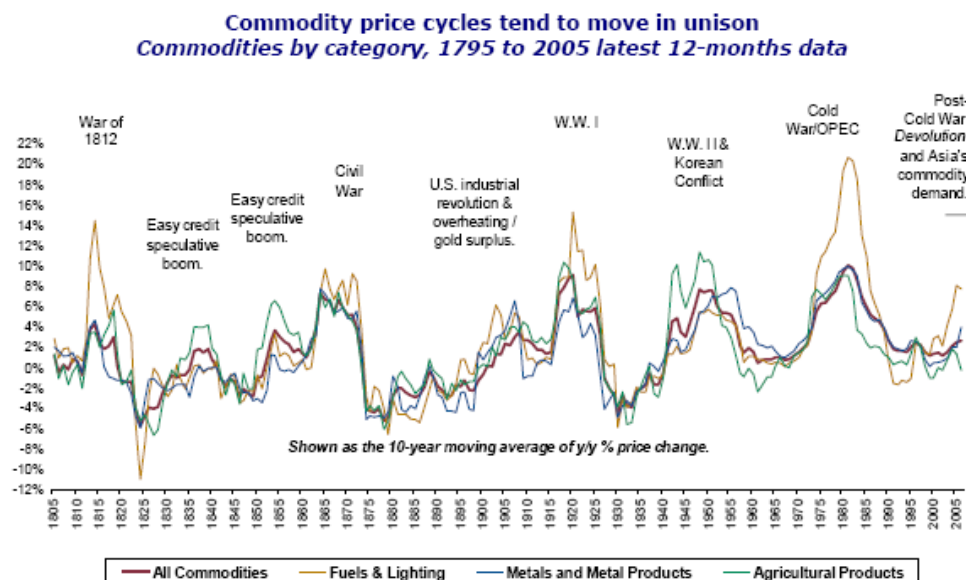
For the purposes of our price analyses, it seems sensible to pick the 4 key bellwether crops, for which price and volume information is plentiful, and which largely drive prices for most of the other globally farmed crops. These are:

- Wheat (and other coarse grains)
- Corn
- Soybean
- Rapeseed

Together, these 4 crops represent around 65% of all arable agriculture.

In terms of timescale, our experience of historic price cycles shows that the typical boom to bust to boom period in agriculture (ie a full cycle) is of the order of 30 years. One could assume that technological advancements should speed up these cycles as markets become quicker at responding to demand surges, and capital quicker at exiting when a downturn sets in. However, the table below

shows remarkable consistency in the shape and length of commodity cycles (including agricultural) over the last 200 years. Indeed the last 3 periods (before the current one) of highest commodity price inflation have been the years just preceding 1920, 1950, and 1980 (on each occasion reflecting periods of extreme global geopolitical tension).



Source: Stifel, Nicolaus & Co., "The Engineering & Construction Industry", 10th Jan 2006. Historical Statistics of the United States: Colonial Times to 1970, a US Census Bureau publication. 1793 to 1890 are the applicable Warren & Pearson US commodity indices. 1891 to 1913 is the Wholesale Commodities Price Index from the BLS and other agencies. 1914 to present is the PPI For All Commodities modern series, about two-third of which are classic commodities.

Given that part of our analytical objective is to gauge the potential value and duration of above-average returns available in this industry, it seems appropriate to use a base case timeframe of 15 years. Based on the above chart, this is a typical half-cycle time period, taking us from boom-time to bust (the period within which the mid- to long-term investor captures his returns, with little assumed by way of terminal value), and it is also on this basis an appropriate time period for discounted cash-flow valuation analysis.

3. Supply, demand and the reserve margin

3.1 Modelling the demand side

Price spikes tend to occur where supply fails to keep up with a sudden increase in demand. It makes sense therefore to start our modelling exercise by understanding what could happen to demand for agricultural produce over the next 15 years, before evaluating the supply response.

Given recent trends in terms of a pick-up in demand from fast developing parts of the world and the likelihood of increasing biodiesel use, it is our view (in consensus with most industry commentators) that medium term agricultural demand growth will remain material. However, the increasing likelihood of a significant slowdown in global economic growth means that we have prudently lowered our demand forecasts in the near term. The table below outlines our base demand forecasts for the period 2008-2023, as compared to previous 15-year periods.

Agricultural commodity demand growth statistics and forecasts 1993-2023

	Av. pa 1961-76	Av. pa 1977-91	Av. pa 1993-2008	Total 1993-2008	Av. pa 2008-23	Total 2008-23
Population growth	2.0%	1.7%	1.4%	22.8%	0.9%	14.4%
Meat consumption growth	3.5%	3.0%	2.6%	47%	2.0%	34.6%
Cereal consumption growth	3.5%	1.8%	1.3%	21.4%	2.0%	34.6%
Oilseed consumption growth	2.9%	4.8%	4.2%	85.4%	3.5%	67.5%

Source: FAO; SP Angel estimates

It is noteworthy that even as world population growth rates have more than halved since the 1960s, significant increases in per capita consumption of grain and meat mean that, even on our conservative estimates, the supply of cereal and meat over the next 15 years will need to increase by a third, and that of oilseeds by two thirds.

As we shall show in the next sections, the scale of this challenge is heightened by the fact that the global availability of arable land has barely grown over the last 20 years, and the costs of increasing crop yields and boosting transport capacity have increased exponentially.

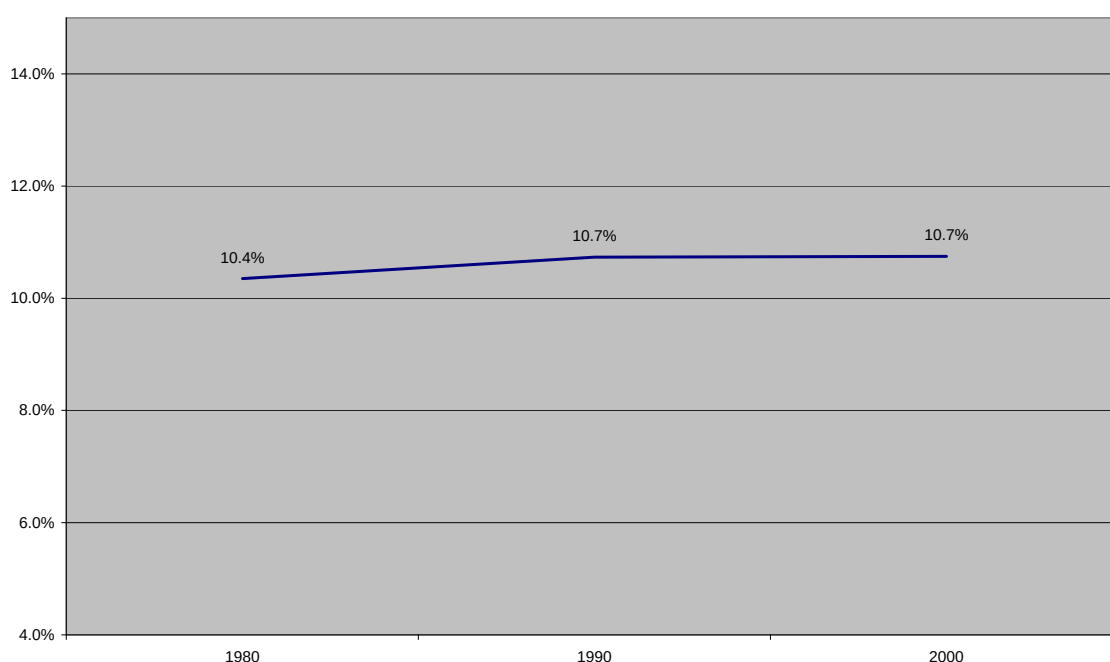
3.2 The supply response dictates the “reserve margin”

We define the reserve margin as the supply levels of an agricultural product (annual production plus previous year-end stocks) in a given year over and above global demand. Mapping the progress of this supply-demand balance is key to understanding how prices have moved and how they are likely to move in the future.

On the supply side of the equation, it is clear, for example, that over the past 20 years (ie since the last price boom and agricultural expansion came to an end) there has been a process of relative under-investment in farmland coupled with accelerated encroachment of the city on the countryside (especially in the developing world). Given that agricultural returns had largely collapsed and the economic rent on urban land was far surpassing that on rural land, this was an entirely logical development.

The table below shows how the total global area of arable land has been largely stagnant over the past two decades.

Progression of arable land as percentage of total world land area 1980-2000

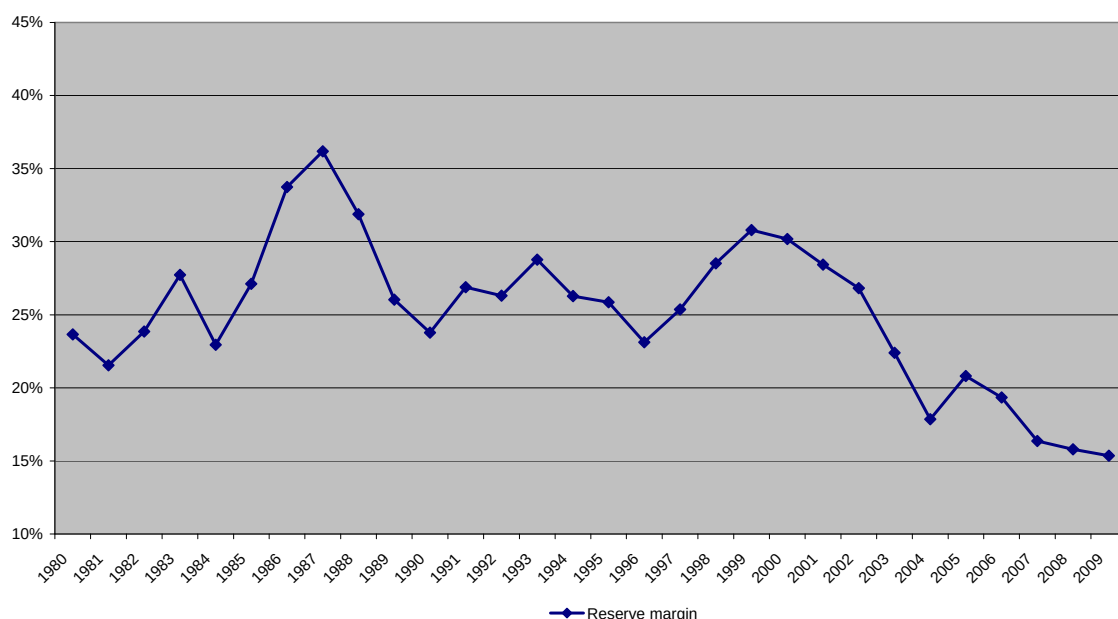


Source: FAO

However, in the last few years this stagnation in the supply side potential (with total arable land remaining at around 1.4bn hectares, or 10.7% of total land area) has coincided, as we showed above, with a boom on the demand side of the equation, led primarily by the well-publicised explosion in developing world growth, and secondarily by newly emerged demands for biofuel crops.

Hence the global agricultural reserve margin has shrunk from the situation of a largely bankrupt excess only 20 years ago to a situation where a “freak weather” year now will make it hard for the industry to meet basic global demand for key crops. Looking at our bellwether crops individually demonstrates similar patterns across agricultural produce.

Wheat and coarse grain global reserve margin 1980-2009

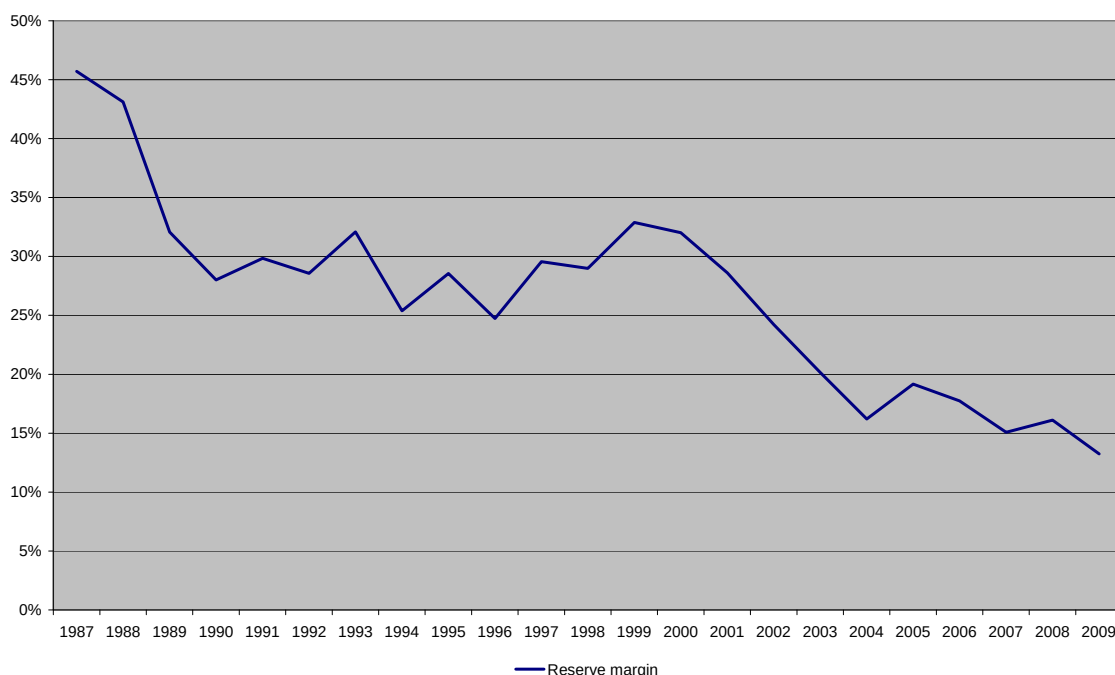


Source: USDA; SP Angel estimates

Generally speaking, reserve margins of over 25%, which we can see in the chart above affected wheat and other coarse grains (sorghum, oats, rye) for most of the 1980s and 1990s, leave farmers with very little pricing power for their produce. Conversely, when reserve margins drop to around 15%, as we have seen over the past 3 years, some real pricing tension can be created in agricultural markets.

Similar reserve margin patterns reveal themselves for corn, as we can see in the chart below:

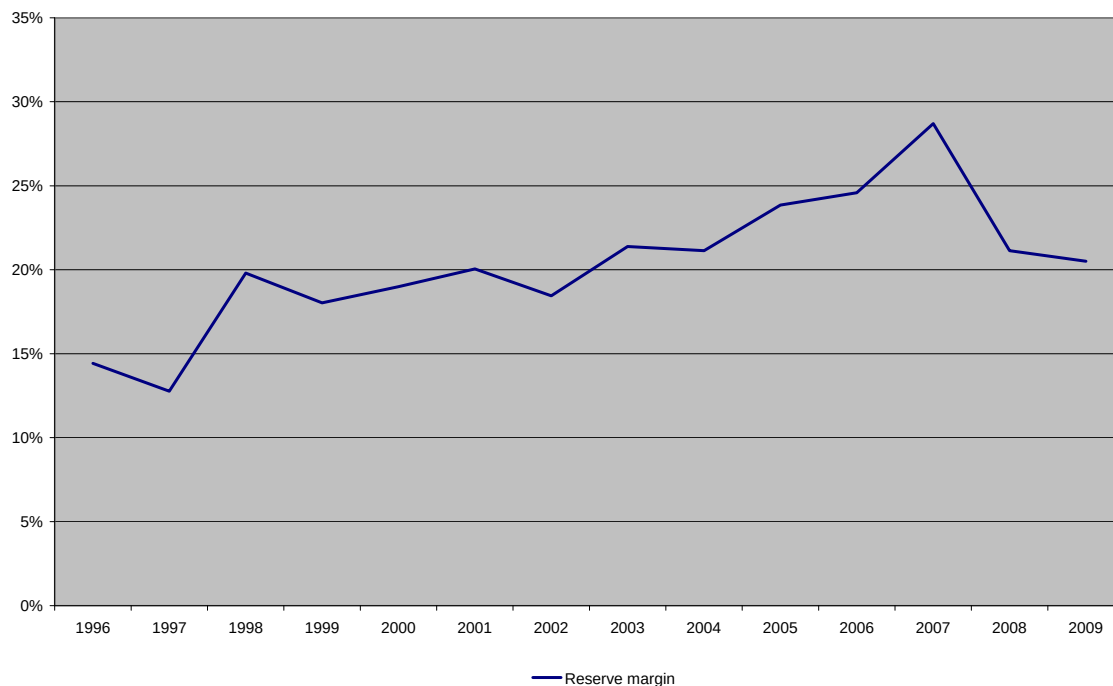
Corn global reserve margin 1987-2009



Source: USDA; SP Angel estimates

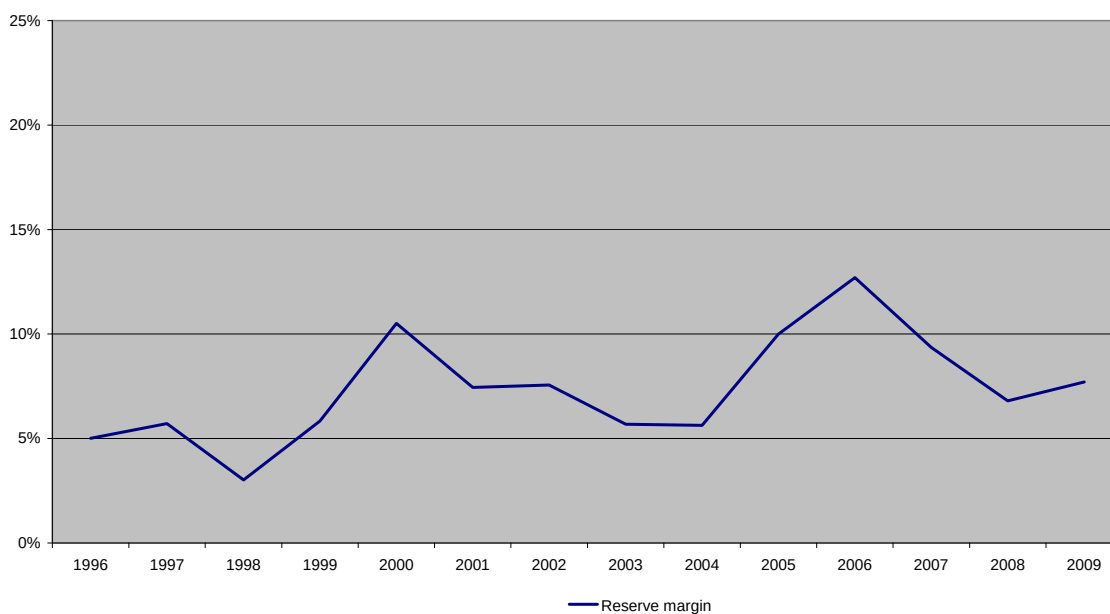
As for the oilseeds in our analysis (soybean and rapeseed), the erratic nature of their reserve margins over the past decade is a reflection of the new and exploding biofuels market. Both the demand and supply sides of the equation have been susceptible to big jumps as the market has expanded, and farmers have reacted.

Soybean global reserve margin 1996-2009



Source: USDA; SP Angel estimates

Rapeseed global reserve margin 1980-2009



Source: USDA; SP Angel estimates

With soybean reserve margins (which had previously benefited from significant stock levels as farmers have ploughed resources into this area) falling to the 20% level this year (and with expectations of further falls) as demand has taken off, and rapeseed barely getting above the 10% level over the past 12 years, the flow-through to higher prices is logical.

A general conclusion from the reserve margin charts above, given that drops to below 15% are the result of over two decades of under-investment, and given that historically it has tended to take the industry over a decade to respond to these signals (time to raise finance; develop new land; invest in higher yields; etc), is that we could see a potential further period of 15 years with reserve margins below 20%, as new investment plays catch-up, which would ensure continued pricing power for farmers over this period.

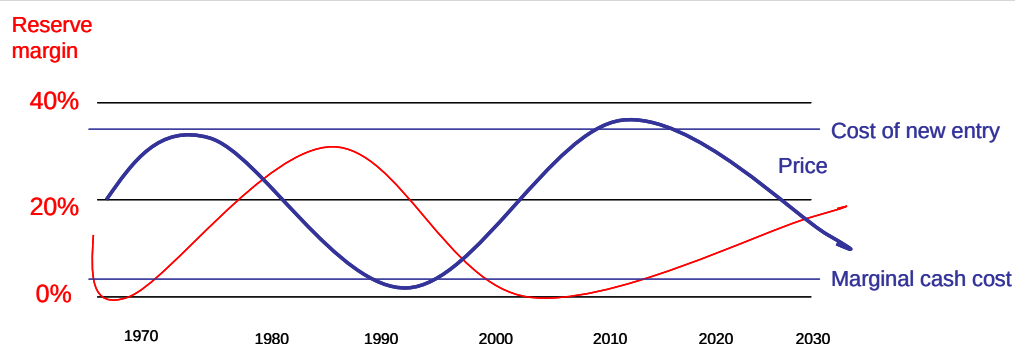
Much, of course, depends on how prices reflect the current situation, and it is this parameter to which we turn next.

4. From supply-demand balance to prices

4.1 How the cycle works in theory and practice

To get a better sense of how the supply-demand balance illustrated above impacts on prices, we should assume, in line with conventional commodity pricing theory, that crop prices move from “marginal cash production costs” at the point where reserve margins reach 30%, and move to “new entry costs” and above when reserve margins fall to around or below 15% (exactly as we are seeing now). The graph below illustrates this typical marginal cost pricing pattern for agricultural (and other) commodities.

Illustrative relationship between reserve margins and price during full cycle

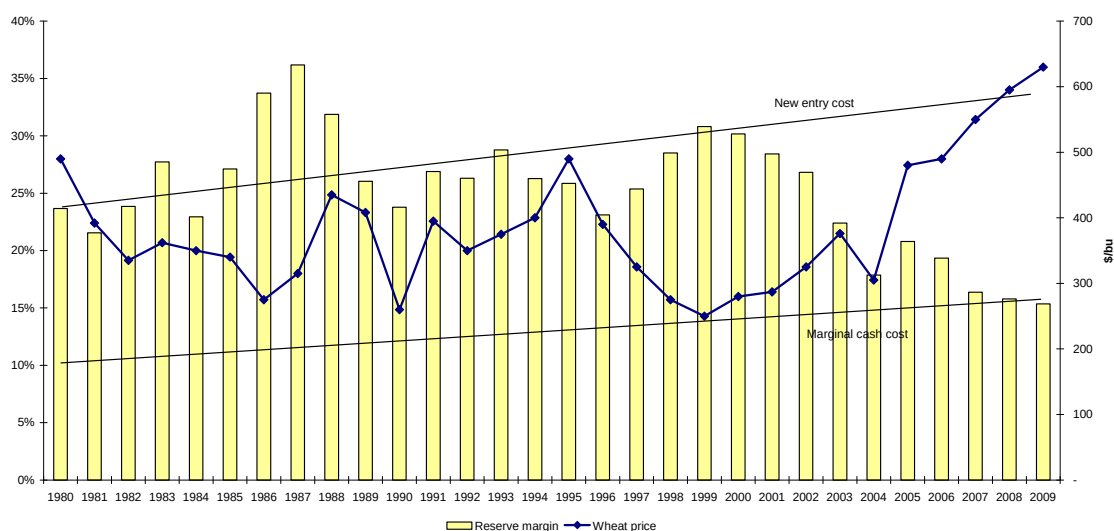


Source SP Angel

The ability to store agricultural produce means of course that price reactions can be delayed, but the fact that total global storage facilities do not represent more than about 30% of global output, and the efficiency of forward price contracting to discount all available supply-demand information, mean that pricing has indeed followed the illustrative pattern depicted above.

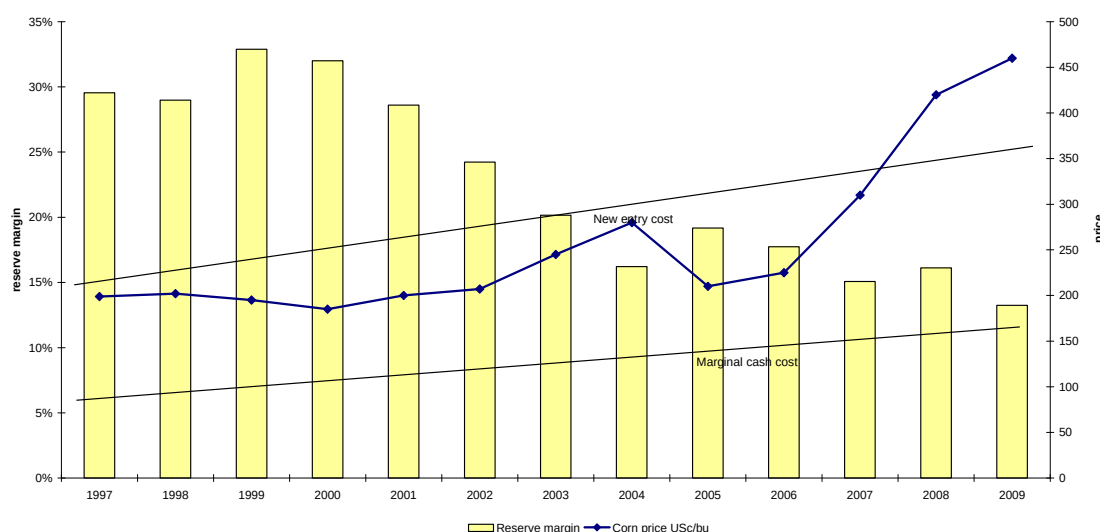
We can see this in the graphs below, where we plot the progress of our bellwether crop prices against our reserve margin and cost estimates over the recent past.

Wheat prices, reserve margin and cost estimates 1980-2009



Source: SP Angel estimates; FAO; USDA

Corn prices, reserve margin and cost estimates 1997-2008

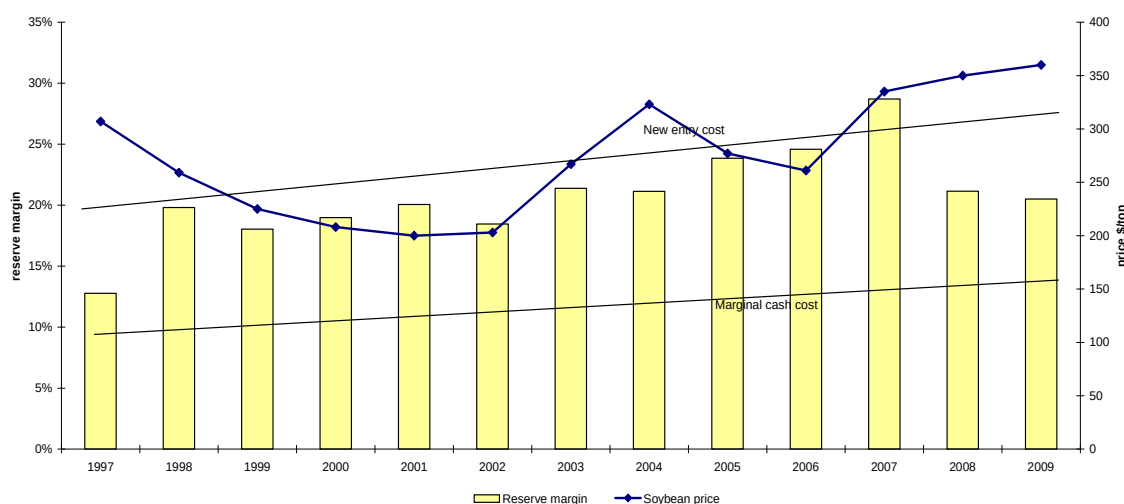


Source: SP Angel estimates; FAO; USDA

The examples of corn and wheat, in the charts above, follow a textbook pattern, with prices remaining well below the level required to stimulate new entry during the 1990s and the first half of this decade, as the majority of years registered reserve margins of well over 20%, with some years over 30%. But 3 years in a row with a reserve margin of around or below 15%, and with most near term forecasts seeing a continuation of this situation, have acted as a wake-up call. Crop prices have shot up to levels where investment in new capacity is starting to look attractive (we go into much greater detail on our derivations of marginal and new entry costs in our price forecasting section below).

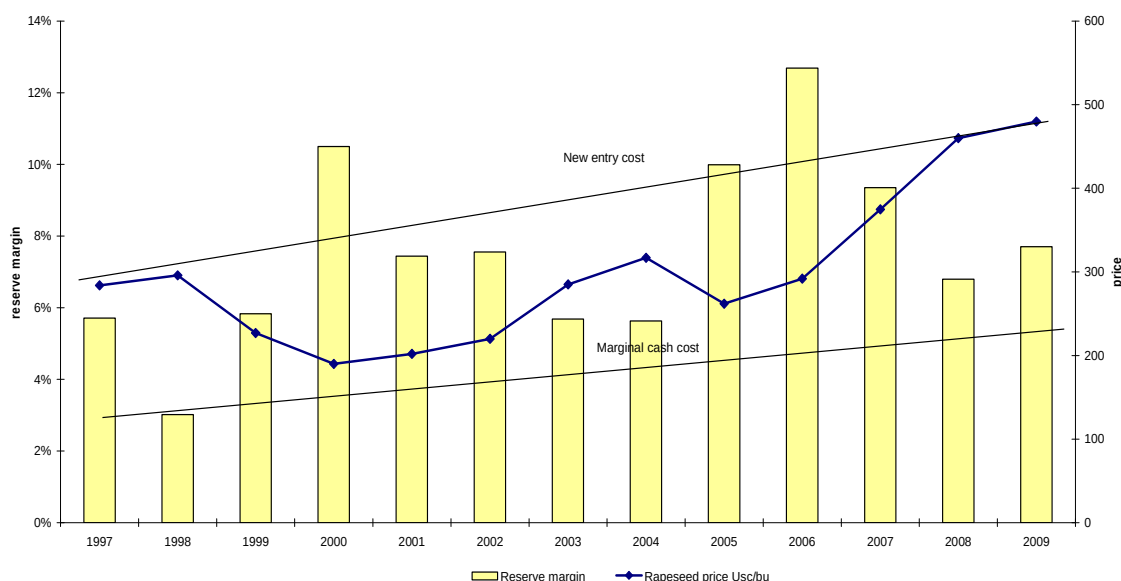
We get similarly “textbook” results when we chart the recent pricing outcomes for the two key oilseeds, soybean and rapeseed, as can be appreciated in the charts below.

Soybean prices, reserve margin and cost estimates 1997-2008



Source: SP Angel estimates; FAO; USDA

Rapeseed prices, reserve margin and cost estimates 1997-2008



Source: SP Angel estimates; FAO; USDA

As with corn, the price spikes for soybean and rapeseed over the past 11 years have come at times when there have been dips in the reserve margin. But these have breached new entry cost levels most significantly over the last 12 months, as expectations have shifted to the view that we are now likely to see a long period with very low reserve margins.

An interesting point which comes out of the analysis above is that, while prices naturally rarely fall below marginal cash cost (there comes a point at which farmers will simply not sell their produce), prices can significantly overshoot new entry costs. And our experience from other commodities (oil, coal, metals, power) is that this can, on occasion, remain the case for a number of years. This is because bottlenecks and inefficiencies can mean that new entry struggles to meet incremental demand even when prices are theoretically encouraging it. For agricultural produce, such influences can include:

- the time required to bring new land into production;
- difficulties in arranging finance;
- transport and storage inefficiencies;
- equipment backlogs;
- freak weather conditions and climate change;
- artificial subsidies; etc.

In this context the resource becomes ever more scarce, and its value to the consumer becomes a bigger determinant of price than the marginal cost of production.

The next stage in our analysis is to use the historic information and pricing model outlined above to drive our forecasts of prices and valuations.

The first challenge is to understand where new supply has to come from to meet our demand growth forecasts as outlined in the demand analysis above.

4.2 Forecasting the supply response

If supply is to meet our forecasts of demand growth over the next 15 years, and re-establish “sustainable” reserve margins in the 20-25% region, then we estimate that two simultaneous processes need to take place:

- Significant new land needs to be brought into agricultural production to reverse the stagnation seen over the past 20 years; and
- Crop yields need to be increased in pre-existing farmland.

In our supply response model for our 4 bellwether crops, we assume that yields per hectare around the world continue to grow, for the next 15 years, at the impressive rate of 1.5% pa experienced during the last 25 years of technological advancement (this rate of increase has been pretty much uniform across the crops in our analysis). Over this same period we assume that our crop reserve margins move from the currently vulnerable 15% level to a more sustainable and comfortable 25%.

From these base assumptions we can then derive the increase in land use required to meet these objectives (and bring crop prices back down the marginal cost levels). In the meantime, prices should theoretically be dictated by the all-in cost of bringing into production the most expensive bushel required to meet these supply objectives (the “marginal bushel” or “peak grain”).

Our workings to derive the required supply response to our forecast demand growth over the next 15 years are summarised in the tables below. We show our workings for each of our 4 crops in turn, and then a table aggregating the results.

Wheat and coarse grain: S P Angel supply response forecasts (2008-2023)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Demand (mt)	1685	1733	1768	1803	1839	1876	1913	1952	1991	2030	2071	2113	2155	2198	2242	2287
% increase		2.8%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Production (mt)	1685	1733	1770	1808	1847	1887	1927	1968	2011	2054	2098	2143	2189	2236	2284	2333
% increase		2.8%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Yr start stock (mt)	266	266	266	269	274	281	292	306	323	342	366	392	423	456	494	536
% increase		0.0%	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Total supply (mt)	1951	1999	2036	2077	2121	2168	2219	2274	2333	2396	2463	2535	2611	2692	2778	2869
% increase		2.5%	1.9%	2.0%	2.1%	2.2%	2.4%	2.5%	2.6%	2.7%	2.8%	2.9%	3.0%	3.1%	3.2%	3.3%
Reserve margin	16%	15%	15%	15%	15%	16%	16%	17%	17%	18%	19%	20%	21%	22%	24%	25%
Yield (t/Ha)	3.1	3.2	3.3	3.3	3.4	3.4	3.5	3.5	3.6	3.6	3.7	3.7	3.8	3.9	3.9	4.0
% increase		2.3%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Land use (mHa)	535	538	541	545	548	552	555	559	562	566	570	573	577	580	584	588
% increase		0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%

Source: SP Angel estimates; USDA; FAO

Corn: S P Angel supply response forecasts (2008-2023)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Demand (mt)	774	795	810	827	843	860	877	895	913	931	950	969	988	1008	1028	1048
% increase		2.7%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Production (mt)	789	775	795	814	834	855	876	898	920	943	967	991	1015	1040	1066	1092
% increase		-1.7%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Yr start stock (mt)	110	125	105	89	77	68	63	62	65	73	85	102	124	151	183	222
% increase		13.4%	-15.5%	-15.2%	-14.0%	-11.5%	-7.3%	-1.5%	5.2%	11.6%	16.7%	19.9%	21.5%	21.9%	21.5%	20.8%
Total supply (mt)	899	900	900	904	911	923	939	960	986	1016	1052	1092	1139	1191	1250	1314
% increase		0.1%	0.0%	0.4%	0.9%	1.3%	1.8%	2.2%	2.7%	3.1%	3.5%	3.9%	4.3%	4.6%	4.9%	5.2%
Reserve margin	16%	13%	11%	9%	8%	7%	7%	7%	8%	9%	11%	13%	15%	18%	22%	25%
Yield (t/Ha)	5.0	4.9	5.0	5.0	5.1	5.2	5.3	5.4	5.4	5.5	5.6	5.7	5.8	5.9	5.9	6.0
% increase		-1.3%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Land use (mHa)	159	158	160	161	163	164	166	168	169	171	172	174	176	178	179	181
% increase		-0.4%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%

Source: SP Angel estimates; USDA; FAO

Soybean: S P Angel supply response forecasts (2008-2023)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Demand (mt)	232	238	246	255	264	273	283	292	303	313	324	336	347	359	372	385
% increase		2.4%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Production (mt)	219	238	246	255	265	274	284	295	306	317	328	340	353	365	379	393
% increase		8.7%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%
Yr start stock (mt)	62	49	49	49	50	51	52	54	57	59	63	67	72	77	83	90
% increase		-21.8%	0.1%	0.6%	1.3%	2.1%	2.9%	3.6%	4.4%	5.1%	5.8%	6.4%	6.9%	7.4%	7.8%	8.1%
Total supply (mt)	281	287	295	305	315	325	337	349	362	376	391	407	424	442	462	482
% increase		1.9%	3.0%	3.1%	3.3%	3.4%	3.5%	3.6%	3.8%	3.9%	4.0%	4.1%	4.2%	4.3%	4.4%	4.4%
Reserve margin	21%	21%	20%	20%	19%	19%	19%	19%	20%	20%	21%	21%	22%	23%	24%	25%
Yield (t/Ha)	2.4	2.5	2.5	2.5	2.6	2.6	2.6	2.7	2.7	2.8	2.8	2.8	2.9	2.9	3.0	3.0
% increase		1.4%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Land use (mHa)	91	97	99	101	103	105	108	110	112	115	117	120	122	125	127	130
% increase		7.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%

Source: SP Angel estimates; USDA; FAO

Rapeseed: S P Angel supply response forecasts (2008-2023)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Demand (mt)	49	51	53	54	56	58	60	63	65	67	69	72	74	77	80	82
% increase		4.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Production (mt)	47	52	54	56	58	60	62	64	66	68	71	73	76	78	81	84
% increase		9.9%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Yr start stock (mt)	5	3	4	5	6	7	8	9	11	12	13	14	16	17	18	19
% increase		-40.1%	27.0%	31.2%	24.2%	19.8%	16.8%	14.6%	12.9%	11.6%	10.5%	9.6%	8.9%	8.3%	7.7%	7.2%
Total supply (mt)	52	55	57	60	63	67	70	73	76	80	84	87	91	95	99	103
% increase		5.3%	4.7%	5.2%	5.1%	5.0%	4.9%	4.8%	4.7%	4.6%	4.5%	4.4%	4.3%	4.3%	4.2%	4.2%
Reserve margin	7%	8%	9%	11%	12%	14%	15%	17%	18%	19%	21%	22%	23%	24%	24%	25%
Yield (t/Ha)	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.2
% increase		3.8%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Land use (mHa)	28	30	30	31	31	32	32	33	34	34	35	36	36	37	38	39
% increase		5.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%

Source: SP Angel estimates; USDA; FAO

Four crop aggregate: S P Angel supply response forecasts (2008-2023)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Demand (mt)	2740	2816	2877	2939	3002	3067	3134	3201	3271	3342	3414	3488	3564	3642	3721	3802
% increase		2.8%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Production (mt)	2740	2798	2865	2933	3004	3076	3149	3225	3302	3382	3463	3546	3632	3719	3809	3901
% increase		2.1%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Yr start stock (mt)	443	442	424	412	406	407	416	431	455	487	527	575	633	701	779	867
% increase		-0.2%	-4.2%	-2.8%	-1.4%	0.3%	2.0%	3.8%	5.4%	6.9%	8.2%	9.3%	10.1%	10.7%	11.1%	11.3%
Total supply (mt)	3183	3240	3289	3345	3410	3483	3565	3656	3757	3868	3990	4122	4265	4421	4588	4768
% increase		1.8%	1.5%	1.7%	1.9%	2.1%	2.4%	2.6%	2.8%	3.0%	3.1%	3.3%	3.5%	3.6%	3.8%	3.9%
Reserve margin	16%	15%	14%	14%	14%	14%	14%	14%	15%	16%	17%	18%	20%	21%	23%	25%
Yield (t/Ha)	3.4	3.4	3.5	3.5	3.6	3.6	3.7	3.7	3.8	3.8	3.9	3.9	4.0	4.0	4.1	4.2
% increase		0.8%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%
Land use (mHa)	812	823	830	838	846	854	861	869	878	886	894	903	911	920	929	937
% increase		1.3%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%

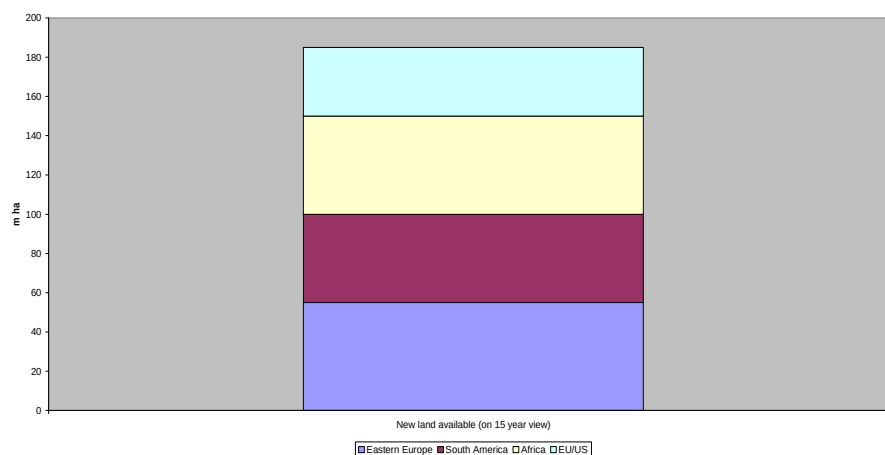
Source: SP Angel estimates; USDA; FAO

Our model shows that if supply-demand equilibrium in our 4 crop types is to be restored over the next 15 years, and assuming yield enhancements continue at the same pace as the last 25 years, then the land utilised will have to increase by around 14%, or 114m hectares, from 2009 to 2023. And this in a context in which the global agricultural land area has remained static for the past 25 years (indeed the wheat harvesting area has actually declined, with the oilseeds making up the difference).

We can extend this exercise for agriculture as a whole. Extrapolating beyond the 4 crop types analysed above for the likes of rice, cotton, fruit, vegetables and sugar (and noting for example that the situation for rice appears particularly acute), then the total global land bank for agriculture would need to increase by 140m hectares (from 1.40bn to 1.54bn hectares) over the next 15 years.

Looking at the global situation in terms of land availability, applicability of soils, irrigation, etc, it is clear that the vast majority of the new farm land requirement is likely to be supplied by South America, Eastern Europe, and Africa. In the chart below we show our estimate of the land available for rapid conversion to arable agriculture (ie on a 15 year timescale) from those areas, as well as from the developed (and more expensive regions) of the European Union and United States.

Estimated potential for additional arable land over next 15 years



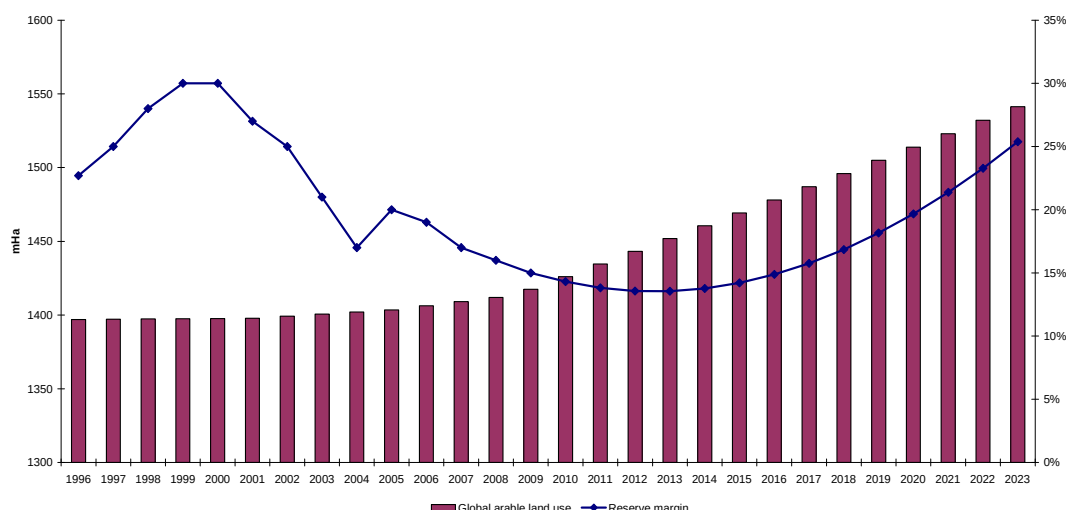
Source: USDA; FAO; SP Angel estimates

If our calculation is correct that the world will require another 140m Hectares, then the above bar chart suggests that these should be available from South America, Eastern Europe, and Africa, without having recourse to more expensive land conversion in Western Europe or North America.

An important point to make about the supply response, before we move on to our analysis of price implications, is that the development of new land may well be slow, and it may therefore take some time for reserve margins to rise meaningfully above the 15% level. Indeed it can take 10 years for new land to be brought into full production.

Our tables above assume that new entry of arable land occurs immediately and evenly over the next 15 years, but even under this optimistic scenario recent production and stock levels have been so low that for more that a decade to come we predict that the capacity of global agriculture to withstand a freak weather year (and respond adequately to demand) will remain vulnerable. The chart below shows this clearly as we plot the progression of reserve margin (which remains low for some years to come) and global land area harvested (across all crop types), based on the historic data and our forecasts, as presented in tabular form above.

S P Angel global arable land area (all crops) and reserve margin estimates 1996-2023



Source: SP Angel estimates; USDA; FAO

The essential vulnerability of this situation, as suggested by the persistence of a tight reserve margin in the above chart, implies that the price path down to marginal cost (if this is what occurs over the next 15 years) may be bumpy rather than smooth.

5. Forecasting prices: between the cost of new entry and the marginal cash cost

5.1 The cost of new entry

The combination of burgeoning demand on one hand and supply which had been squeezed by previous under-investment is naturally pushing prices for the first time in 30 years to where they need to be to stimulate new investment for increased production (the new entry cost).

New investment for increased production capacity is taking 2 forms: (1) new technologies on existing land to increase yield; and (2) new land development, primarily in the developing economies of South America, Eastern Europe, and Sub-Saharan Africa.

Our analysis above suggests that, given the scale of the supply challenge facing the agriculture industry, each of these areas of new investment will be needed simultaneously if global demand is to be met and reserve margins are to return to healthy levels.

Given that farmers largely respond to the incentive of a global price for their produce – notwithstanding local subsidies - crop prices are likely to be determined (in a tight supply-demand situation) by the cost of bringing into production the most expensive of the solutions which are actually required.

In the table below, we show the results of our analysis of the cost of new entry for wheat, depending on whether the required new land is developed in Eastern Europe, South America, Sub-Saharan Africa, or the EU/US.

S P Angel cost of new entry analysis for wheat, across different geographies

	Eastern Europe	South America	Sub-Saharan Africa	US/EU
Operating costs				
Seed/fertilizer (\$/Ha)	185	190	200	180
Lime (\$/Ha)	28	28	28	28
Power (\$/Ha)	49	49	49	49
Labour (\$/Ha)	32	45	20	60
Machine maintenance (\$/Ha)	12	12	12	12
Transport/storage/drying (\$/Ha)	15	15	15	15
Leasing (\$/Ha)	60	60	50	70
Overheads/insurance (\$/Ha)	44	44	44	44
Total operating costs (\$/Ha)	425	443	418	458
Assumed starting yield (t/Ha)	5.0	5.0	4.0	7.5
Total operating costs (\$/t)	85	89	105	61
Capital costs				
Land purchase/clearance (\$/Ha)	1800	1300	600	18000
Farm/transport infrastructure (\$/Ha)	0	350	250	0
Machinery (\$/Ha)	360	360	360	360
Land irrigation/habilitation (\$/Ha)	0	500	400	0
Total capital costs (\$/Ha)	2160	2510	1610	18360
Assumed starting yield (t/Ha)	5.0	5.0	4.0	7.5
Total capital costs (\$/t)	432	502	403	2448
Depreciation capital costs (\$/t)	5	9	10	3
Weighted Average Cost of capital (%)	17%	17%	22%	10%
Cost of capital, inc working (\$/t)	88	100	112	251
Total annualised costs	178	198	226	315

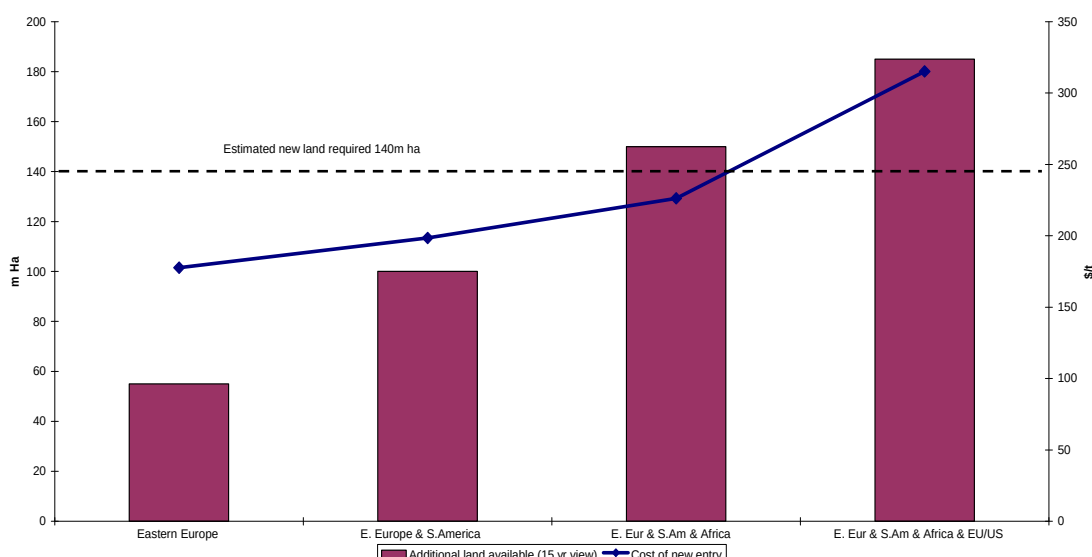
Source: SP Angel estimates

The above table suggests that when wheat prices rise above \$178/t, it becomes profitable for new land to be converted in Eastern Europe (including Russia and Ukraine); when it rises above \$198/t it becomes profitable to clear new land in South America; when it reaches \$226/t then new land is converted in Sub-Saharan Africa; and if wheat prices were to reach \$315/t then it would be profitable to develop new arable land in Western Europe and the US for the first time in decades.

It seems that the current wheat price (at \$225/t) is efficiently reflecting the need, in the short to medium term, for new arable land to be brought on stream in Africa (“peak grain”), as well as Eastern Europe and South America, if reserve margins (or stocks-over-use) are to be pushed up from the currently precarious 15% levels to a more secure 25%.

The chart below demonstrates this graphically by showing the additional land available (as the geographies are added up in order of cost) next to the price required to incentivise the farmers in each area.

S P Angel calculation of marginal geographies and the cost of new entry



Source: SP Angel estimates; USDA; FAO

Again, we reach the same conclusion that it is unlikely that a growing crop demand will be met globally (with an acceptable surplus) without new land being converted to arable in Africa, but that this new land will not be developed unless prices remain at levels of at least \$226/t. If Africa fails to respond then the burden of meeting marginal demand will fall on Western Europe and North America, where we calculate new entrant cost at \$315/t (40% above current price levels).

It is noteworthy that at a wheat price of \$226/t, potential earnings in Eastern Europe reach levels of around \$136/t, or 26% return on capital (against our assumed cost of capital for the region of 17%). And at a price of \$315/t, returns on new investment in E.Europe would be 43%.

The cost analysis above is based on wheat, but there are differences in yields and harvesting costs which create divergences for the new entry costs of corn and the oilseeds in our analysis. The table below summarises these differences.

S P Angel summary costs of new entry for wheat, corn, soybean and rapeseed \$/t

	Eastern Europe	South America	Sub-Saharan Africa	US/EU
Wheat	178	198	226	315
Corn	138	154	176	245
Soybean	267	298	340	473
Rapeseed	345	385	439	612

Source: SP Angel estimates

Clearly there is a time lag between price signals prompting new investment in agriculture and the successful boosting of production, and so during this transition period prices can significantly exceed new entry costs.

The flipside of this analysis, of course, is that when farmers around the world eventually do react to crop prices breaking through new entry cost levels, and start developing new arable land, the day eventually comes when reserve margins get back at healthy levels. At this point intense competition from the supply side can lead to significant price falls. And if the market entirely lacks supplier discipline, the natural low point for prices becomes the marginal cash cost of production. In our pricing model, this represents the natural end-point in our 15-year boom to bust scenario.

5.2 Marginal cash cost

The calculation of marginal cash costs, for extrapolating potential prices during times when the reserve margin of the agricultural land bank is particularly high, is simply the incremental cost of adding an additional tonne of output once all the fixed costs have already been absorbed within the industry.

Using the detailed example of wheat, as above, our calculation of marginal cash cost across the 4 key geographies in our study is outlined in the table below.

S P Angel marginal cash cost analysis for wheat across 4 key geographies

	Eastern Europe	South America	Sub-Saharan Africa	US/EU
Seed/fertilizer (\$/Ha)	185	190	200	180
Lime (\$/Ha)	28	28	28	28
Power (\$/Ha)	49	49	49	49
Labour (\$/Ha)	32	45	20	60
Machine maintenance (\$/Ha)	12	12	12	12
Transport/storage/drying (\$/Ha)	15	15	15	15
Leasing (\$/Ha)	60	60	50	70
Overheads/insurance (\$/Ha)	44	44	44	44
Total cash operating costs (\$/Ha)	425	443	418	458
Assumed starting yield (t/Ha)	5.0	5.0	4.0	7.5
Marginal cash cost of production (\$/t)	85	89	105	61

Source SP Angel estimates

With African farmland pretty firmly entrenched as the “peak grain” or marginal producer (even under a 10% demand collapse scenario), the cash operating costs of production in Africa seem to provide the floor price for global produce.

It is interesting to note therefore that even if the supply response is strong enough over the next 15 years to bring prices down to this level, the relatively low production costs in Eastern Europe would still allow for positive EBITDA for wheat in that region of \$20m/t (an annualised return on capital of just over 4%).

We show in the table below a summary of the equivalent analyses for the other crop types in our study.

S P Angel summary marginal cash costs of production for wheat, corn, soybean, rapeseed \$/t

	Eastern Europe	South America	Sub-Saharan Africa	US/EU
Wheat	85	89	105	61
Corn	66	69	81	47
Soybean	128	133	157	92
Rapeseed	165	172	203	119

Source: SP Angel estimates

Having modeled an approximation of peak to trough pricing, based on commodity price theory and current industry cost levels, we can now outline some potentially realistic price forecasting scenarios, which is the final step before we can create valuation matrices for global farming.

5.3 Price forecasting

We can now overlay our reserve margin (supply-demand) forecast with appropriate price profile forecasting for the relevant crops. In order to include some sensitivity analysis, we outline a base case scenario as well as bull and bear case scenarios:

- As a base case, for a 15-year projection period, we take the forward market price curve for years 1 and 2, followed by our calculation of new entry cost for a further 7 years (ie the period during which we forecast reserve margins remain at or below 15%), followed by gradual decline to marginal cash cost over following 6 years.
- As a high case, we model prices remaining at new entry levels for 10 years beyond year 2, before declining rapidly to marginal cash cost by year 15.
- As a low case, we model prices holding up at new entry levels for just 3 years beyond year 2, before declining to marginal cash cost by year 15.

The table below shows our pricing forecasts for our 4 bellwether crops, on the base, high and low case scenarios as outlined above.

S P Angel crop price forecast scenarios 2008-2023 (\$/t)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Wheat																
Base case	195	225	226	226	226	226	226	226	226	209	191	174	157	139	122	105
High case	195	225	226	226	226	226	226	226	226	226	226	226	196	165	135	105
Low case	195	225	226	226	226	215	204	193	182	171	160	149	138	127	116	105
Corn																
Base case	152	175	176	176	176	176	176	176	176	162	149	135	122	108	95	81
High case	152	175	176	176	176	176	176	176	176	176	176	176	152	129	105	81
Low case	152	175	176	176	176	167	159	150	142	133	124	116	107	98	90	81
Soyabean																
Base case	328	338	340	340	340	340	340	340	340	314	288	261	235	209	183	157
High case	328	338	340	340	340	340	340	340	340	340	340	340	294	248	203	157
Low case	328	338	340	340	340	323	307	290	273	257	240	223	207	190	174	157
Rapeseed																
Base case	401	437	439	439	439	439	439	439	439	406	372	338	304	270	237	203
High case	401	437	439	439	439	439	439	439	439	439	439	439	380	321	262	203
Low case	401	437	439	439	439	418	396	375	353	332	310	289	267	246	224	203

Source SP Angel estimates

The chart below demonstrates graphically the base, high and low case scenarios for wheat prices over the next 15 years.

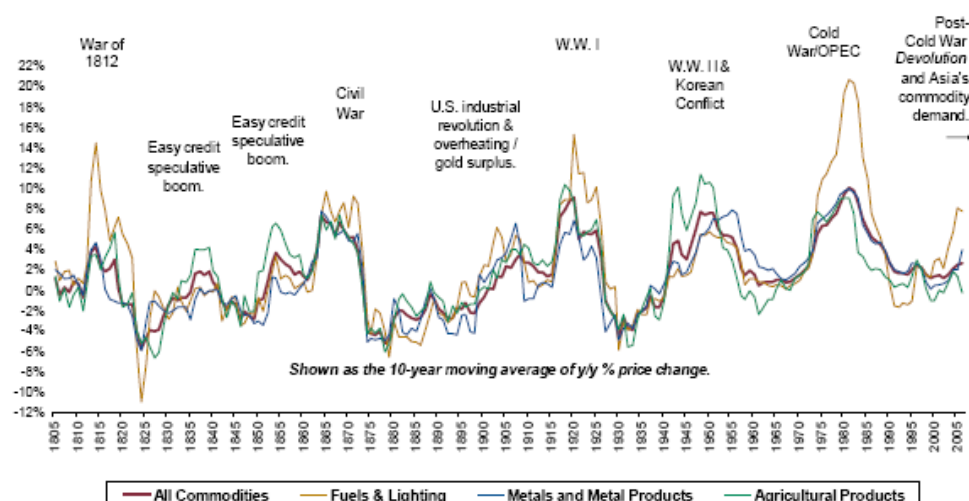
S P Angel wheat price forecast scenarios 2008-2023 (\$/t)



Source SP Angel estimates

It may be relevant to note that the process and pace of our base case crop price scenario follow the same general pattern as the last 6 boom to bust profiles over the last 2 centuries. Using the same 5 year intervals as in the graph below, these 6 rough precedents are the approximate periods 1810-1825; 1830-1845; 1865-1880; 1915-1930; 1950-1965; and 1980-1995.

Commodity price cycles tend to move in unison
Commodities by category, 1795 to 2005 latest 12-months data



Source: Stifel, Nicolaus & Co., "The Engineering & Construction Industry", 10th Jan 2006. Historical Statistics of the United States: Colonial Times to 1970, a US Census Bureau publication. 1793 to 1890 are the applicable Warren & Pearson US commodity indices. 1891 to 1913 is the Wholesale Commodities Price Index from the BLS and other agencies. 1914 to present is the PPI For All Commodities modern series, about two-third of which are classic commodities.

The price forecast scenarios which we have derived allow us now to build a valuation framework for the crops analysed.

6. Deriving a value for land and businesses

6.1 Valuation framework: forecasting cashflows

Whereas farms everywhere largely receive a global price for their produce (notwithstanding regional subsidies), and largely pay a global price (or near enough) for key input costs such as fertilizer and equipment, there are a number of cost items which show significant variability across regions. These include labour, processing, transport, and, of course, capital costs.

In our valuation exercise we have therefore focused on four different geographical areas to highlight the impact of this cost variability:

- The US/EU, representing the developed agricultural world, characterized by generally higher input costs, offset by advanced technologies and high crop yields;
- Eastern Europe (mainly Russia and Ukraine), representing excellent land quality but typically archaic infrastructure, low crop yields and a low variable cost base;
- South America (mainly Brazil and Argentina), showing similar characteristics to Eastern Europe, but with generally higher labour and land clearance costs; and
- Sub-Saharan Africa, representing the frontier lands for agricultural development, with very low variable costs, but significant requirements in terms of equipment and transport infrastructure, and higher costs of capital.

Clearly crops are rotated on a given piece of land, but for the sake of this valuation exercise we use wheat as our base crop and assume that margins are generally similar across divergent crops. In the table below, therefore, we summarise the price received for wheat per hectare in each of these geographies (which varies according to yield) and the unit costs per hectare associated with each geography. We can then derive a cashflow per hectare figure for each year and location.

SP Angel wheat cashflow per Ha summary forecast across 4 geographies (base case prices)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
US/EU																
Price \$/t	195	225	226	226	226	226	226	226	226	209	191	174	157	139	122	105
Yield t/ha	7.5	7.6	7.7	7.8	8.0	8.1	8.2	8.3	8.4	8.6	8.7	8.8	9.0	9.1	9.2	9.4
Price \$/ha	1463	1713	1748	1774	1801	1828	1855	1883	1911	1791	1666	1538	1405	1268	1126	980
Opex \$/ha	458	465	472	479	486	493	501	508	516	524	532	540	548	556	564	573
Capex \$/ha	24	24	25	25	25	26	26	27	27	27	28	28	29	29	30	30
Pre-tax cashflow \$/ha	981	1224	1251	1270	1289	1308	1328	1348	1368	1240	1107	970	829	683	532	377
Eastern Europe																
Price \$/t	195	225	226	226	226	226	226	226	226	209	191	174	157	139	122	105
Yield t/ha	5.0	5.1	5.2	5.2	5.3	5.4	5.5	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3
Price \$/ha	975	1142	1165	1183	1200	1218	1237	1255	1274	1194	1111	1025	937	845	751	653
Opex \$/ha	425	431	438	444	451	458	465	472	479	486	493	501	508	516	523	531
Capex \$/ha	24	24	25	25	25	26	26	27	27	27	28	28	29	29	30	30
Pre-tax cashflow \$/ha	526	686	703	713	724	735	746	757	768	680	590	496	400	300	198	92
South America																
Price \$/t	195	225	226	226	226	226	226	226	226	209	191	174	157	139	122	105
Yield t/ha	5.0	5.1	5.2	5.2	5.3	5.4	5.5	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3
Price \$/ha	975	1142	1165	1183	1200	1218	1237	1255	1274	1194	1111	1025	937	845	751	653
Opex \$/ha	443	450	456	463	470	477	484	492	499	507	514	522	530	538	546	554
Capex \$/ha	47	48	49	49	50	51	52	53	53	54	55	56	57	57	58	59
Pre-tax cashflow \$/ha	485	644	660	670	680	690	701	711	722	633	542	448	350	250	147	40
Sub-Saharan Africa																
Price \$/t	195	225	226	226	226	226	226	226	226	209	191	174	157	139	122	105
Yield t/ha	4.0	4.1	4.1	4.2	4.2	4.3	4.4	4.4	4.5	4.6	4.6	4.7	4.8	4.9	4.9	5.0
Price \$/ha	780	914	932	946	960	975	989	1004	1019	955	889	820	749	676	601	523
Opex \$/ha	418	424	431	437	444	450	457	464	471	478	485	492	500	507	515	523
Capex \$/ha	41	41	42	43	43	44	44	45	46	46	47	48	49	49	50	51
Pre-tax cashflow \$/ha	321	448	460	467	474	481	488	495	503	431	356	280	201	119	36	-51

Source: SP Angel estimates

6.2 From cashflows to valuations

Having derived the base case cashflows for arable farming across our 4 key geographies, the next stage is to value those cashflows. We use DCF methodology to do this as it seems the most appropriate valuation tool for mid- to long-term cash-based forecasts.

Clearly, agriculture in Africa or the former Soviet Union brings with it different sets of risk factors (whether economic or political), and these, as well as the differing cost base, need to be taken into account in valuing land and agricultural companies in these areas. We account for these differing risks by assigning differential discount rates to our DCF valuations: 10% in US/EU; 17% in South America and Eastern Europe; and 22% in Africa.

In the table below, we show the base case results of our valuation of these cash flow streams, expressed in multiples per hectare, per tonne and per unit of EBITDA.

S P Angel summary base case valuations for arable farming across 4 geographies (\$)

	EV/Ha	EV/t	EV/Ebitda
US/EU	9690	1292	9.6
Eastern Europe	3509	702	6.4
South America	3248	650	6.1
Sub-Saharan Africa	1802	451	5.0

Source: SP Angel estimates

In the tables below, we carry out the same exercise using our high case and low case crop price forecasts (as described above).

S P Angel summary high case valuations for arable farming across 4 geographies (\$)

	EV/Ha	EV/t	EV/Ebitda
US/EU	10194	1359	10.1
Eastern Europe	3667	733	6.7
South America	3407	681	6.4
Sub-Saharan Africa	1879	470	5.2

Source: SP Angel estimates

S P Angel summary low case valuations for arable farming across 4 geographies (\$)

	EV/Ha	EV/t	EV/Ebitda
US/EU	8873	1183	8.8
Eastern Europe	3205	641	5.8
South America	2944	589	5.5
Sub-Saharan Africa	1637	409	4.5

Source: SP Angel estimates

Of course, there are many variable factors which can affect these valuations - soil quality, clearance costs, transport links, subsidies, fertilizer pricing, etc. - and when looking at individual farms or companies, we need to make adjustments to our average benchmarks for such situation-specific issues.

6.3 So where's the value now?

While keeping in mind the caveats made in the last paragraph, an interesting final exercise for this report is to compare the theoretical valuation work above with actual current average arable land values across the 4 geographies in our analysis. The table below uses our base case valuation numbers.

S.P.Angel agricultural land valuations compared to actual current land values \$/ha

SPAngel valuation		Current land values	
US/EU	9690	US	8000
		UK	18000
Eastern Europe	3509	Russia	1000
		Ukraine	1500
South America	3248	Brazil	3400
Sub-Saharan Africa	1802	Mozambique	1100

Source: SP Angel estimates

An obvious conclusion, therefore, which provides the backbone to the main thesis of this research note, is that whereas current land prices are efficiently discounting the effect of soaring commodity prices in the developed world, they have not yet fully done so, in our opinion, in key areas of the developing world, notably Eastern Europe.

But such a framework for the valuation of agricultural land, and companies invested in agriculture, is designed not so much as the endgame of the analysis but rather a starting point for discussions of similarities and differences between crops, regions and business models within individual geographies. Each individual company, as we have already mentioned, will have specific characteristics which justify some adjustment to the benchmark valuations in the table above. This research, however, will hopefully help to point investors in the right direction and provide them with a powerful tool for appraising the different investment options which they face.

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