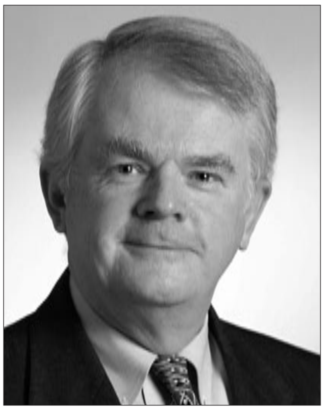
Applying modern portfolio techniques to agriculture

Despite agriculture's recent poor financial performance, returns to the best performing agricultural operations in Australia have roughly matched those from other sectors of the economy. Because these returns move relatively independently of other asset classes, this sector should form part of a well-diversified portfolio.



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AGRICULTURE IS ONE OF THE FEW asset classes with poor financial performance in recent times. Although this intuitively suggests a rare counter-cyclical investment opportunity, everyone 'knows' that low returns are chronic although this 'knowledge' is qualified by the fact that the industry's finances are a research desert. The few published statistics are broad samples, considered to be unreliable, and are too general to dissect finances by region and product. Arguably, however, an investment sector with historically poor returns and weak analysis offers unexploited profit opportunities.

This paper gives a brief overview of agriculture in Australia, discusses drivers of returns in its principal sectors, and then applies modern financial techniques to develop an optimised portfolio. The result is a model that should produce a solidly performing, low-risk portfolio of diversified agricultural investments.

Australia's agricultural industry

Agriculture, including fishing and forestry, currently contributes 3% to Australia's GDP: this has fallen from 4% since the mid 1980s. Over half the country's land area is used in agriculture, and crops alone cover 4% of Australia.

Australia has 130,000 farms and their annual production is almost $40 billion, principally from: cattle (contributing about 20% of the total); cereals, primarily wheat (16%); sheep and wool (12%); and dairy (9%). Smaller, but still significant, sectors include forestry and fishing, high-value produce (such as stone fruit, nuts, olives), vegetables, wine, poultry, sugar cane, cotton and pigs. All other sectors, including emergent areas such as coffee, truffles, medicinal herbs, and organic foods, contribute 10% of the total.

Two-thirds of Australian agricultural production is exported and comprises a quarter of merchandise exports.

This makes Australian agriculture globally important, and it contributes around half of global wool trade, 20% of beef, 14% of wheat and 7% of global cotton trade.

There is no doubt that the industry is undergoing rationalisation: farm numbers fell by 12% in the past decade, while livestock numbers and crop areas rose. This has been driven partly by economic factors, as discussed below. Much, however, is due to demographic change as the rural workforce is ageing rapidly, with most farmers aged in their fifties, and a shortage of labour. This is promoting consolidation of properties, introduction of new technologies and a significant increase in productivity.

Agricultural returns and their drivers

Rates of return from major agricultural sectors in Australia averaged 8% per year this decade, of which less than 1% came from farm operations, with the balance in asset appreciation. The best return from operations was 4% per year from crops, followed by dairy, with livestock close to zero. However, most farms in Australia are small, unprofitable ventures that are run for reasons other than operational return: for instance, only 1% of farms have annual revenues in excess of $2 million.

The rate of return from the largest farms is around 10–12% per year, with 6–8% in capital appreciation and the rest from operations. Large, modern farms are run like manufacturing plants and utilise the latest technologies from robots and GPS to complex information management systems. Their returns are comparable to well-run conventional businesses (Carroll, 2004).

The best way to understand the finances of agricultural investments with scale is to analyse Australia's listed agricultural companies. Their risk and return are calculated using a simple capital asset pricing model:

$$R_{i,t} = \alpha_i + \beta_{i,m} R_{m,t} + \varepsilon_{i,t}$$

where $R_{i,t}$ is the market return on stock i from day $t-1$ to day t; α_i, 'alpha', is a constant; $R_{m,t}$ is the daily return on the market index; $\beta_{i,m}$, 'beta', reflects the sensitivity of the price of stock i to movements in the broad market; and $\varepsilon_{i,t}$ is an error term.

TABLE 1

Panel A – Financial results for listed Australian agribusinesses 2001–2006

Agribusiness sector	Alpha % p.a.	Beta % p.a.
Aquaculture	-10.5	0.15
Broad acres	9.4	0.71
Dairy	0.5	0.53
Eggs	-2.3	0.32
Fibres	-4.6	0.46
Food processing	4.8	0.37
Forestry	6.2	1.16
Fruit	-0.4	0.46
Other foods	3.1	1.06
Wine	-19.6	0.73

TABLE 1: **Panel B: Significant (p<0.1) correlations between agricultural sector returns**

	Aqua-culture	Broad acres	Dairy	Eggs	Fibres	Food processing	Forestry	Fruit	Other foods	Wine	All Ords Index
Aqua-culture	1										
Broad acres		1									
Dairy			1								
Eggs	0.237**			1							
Fibres	0.217**		0.393**	0.311***	1						
Food Processing		0.232*			0.210**	1					
Forestry		0.480***			0.232**	0.352***	1				
Fruit	0.255**		0.288*		0.219**	0.176*	0.184*	1			
Other foods		0.268**	0.355**		0.373***	0.216**	0.326***		1		
Wine						0.265**	0	.253**	0.178*	0.296***	1
All Ordinaries Index		0.293**	0.237**		0.227**	0.212*	0.468***		0.437***	0.211*	1

*,**,*** Correlations are significant at the 10, 5 and 1% levels.

The 23 principal listed Australian agricultural firms were analysed using monthly closing prices for the six years to December 2006, which covers the last full cycle in commodity prices. Firms were classified into 11 broad groups as shown in Table 1, with alphas and betas reported in Panel A and significant correlations between sector returns in Panel B. Figures are unweighted averages for firms in each sector.

Panel A shows the sectors that have been least influenced by the All Ordinaries Index (and thus would have provided greatest diversification). They are aquaculture, eggs, food processing and fruit. Conversely, forestry and other foods (such as ginger, sugar, olives and nuts) would have provided limited diversification.

This is confirmed by Panel B which shows low correlations ($R<0.3$) between movements in the All Ordinaries Index and the prices of shares in most agricultural sectors, except forestry and other foods. Moreover, price movements in many sectors are not correlated ($p>0.1$) with each other. Thus, for instance, patterns in returns from aquaculture, eggs and wine are quite different from broad acres, forestry and food processing which move together.

Agriculture remains a commodity business where prices are set in competitive global markets. Moreover, many producers are supported by subsidies: across the OECD a third of farmers' gross income is from government (although the corresponding figure is 5% in Australia). Furthermore, farmers have little bargaining power against their suppliers, and it is extremely difficult to achieve product differentiation.

Thus, even though farm productivity has increased, this has not improved returns because real commodity prices are in long-term decline. For example, the Reserve Bank maintains an Index of Rural Commodity prices: since a low in the early 1980s, it has risen by 71% in Australian dollars, whereas inflation has risen by 167%.

Figure 1 provides more granularity and shows the long-term price trend in nominal US dollars for two major Australian commodities, cotton and wheat. With the exception of grain prices, which have risen in the past few years, the prices of major agricultural commodities have followed cotton and changed little in nominal terms since the 1980s.

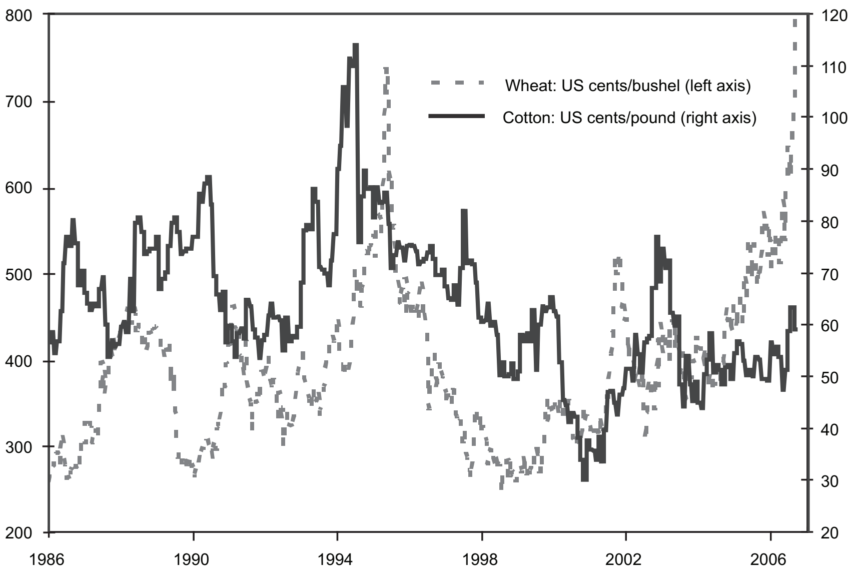
Another important exogenous influence on farm returns is the climate, and a third of the variability in agricultural production in Australia is due to rainfall (White, 2000). The final contributor to farm returns is managerial skill, where, as with other industries, performance is serially correlated.

Moving beyond operational factors, capital appreciation can often be a substantial component of the total returns to agriculture. A study of land prices in New South Wales by Eves (2002), for instance, found an average annual increase of 9.5% during the 1990s, which was considerably higher than that of residential or investment property. This is confirmed by an index of rural land values maintained by property agents Meares and Associates that shows average annual increases between 1978 and 2006 of 6–11% [www.meares.com.au/news.htm].

Another rural asset whose value has risen in real terms is water, and licences to use irrigation in western NSW have been rising at about 15–20% per year. While the reasons for these increases in asset values are complex, they probably cannot continue without a significant improvement in returns from farm operations.

Finally, there is a set of positive influences on Australian agriculture, as its international competitiveness is high and should improve as subsidies in other countries are being reduced. Quality is high, too, with a clean, green image. Domestically there is strong bi-partisan political support for rural interests, which benefits agriculture in many ways from improved infrastructure to better training facilities.

FIGURE 1: **International commodity prices**



Building an agricultural portfolio

The analysis above shows that returns from agriculture investment are determined by a combination of rainfall and commodity prices, and farm management and asset appreciation. The first two factors are not within investors' control and are essentially unforecastable. This suggests that the associated risks are best managed through diversification so that investments are chosen to spread funds across regions and sectors where returns are unlikely to move down together. Thus, the first step in building an agricultural investment portfolio is to identify regions where rainfall is uncorrelated and sectors where commodity prices are uncorrelated. The second two factors driving agriculture returns – farm management and asset appreciation – are specific to each investment and require selection of top-performing projects.

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To diversify rainfall risk requires identifying clusters of regions within Australia where variations from long-term rainfall are uncorrelated, so that investments across them are naturally hedged against drought. The analysis here starts with 46 regions developed by CSIRO that are 'relatively homogenous with respect to climate, landscape, geology, soil type and vegetation' (Australian State of the Environment Committee, 2001). A representative rainfall station was identified close to the geographical centre of each region, with multiple sites for large regions to give a total of 58 stations. The Queensland DPIE database *Rainman* provided monthly rainfall figures for the 50 years to end of 2004, which enabled calculation at each station of quarterly deviations from mean rainfall.

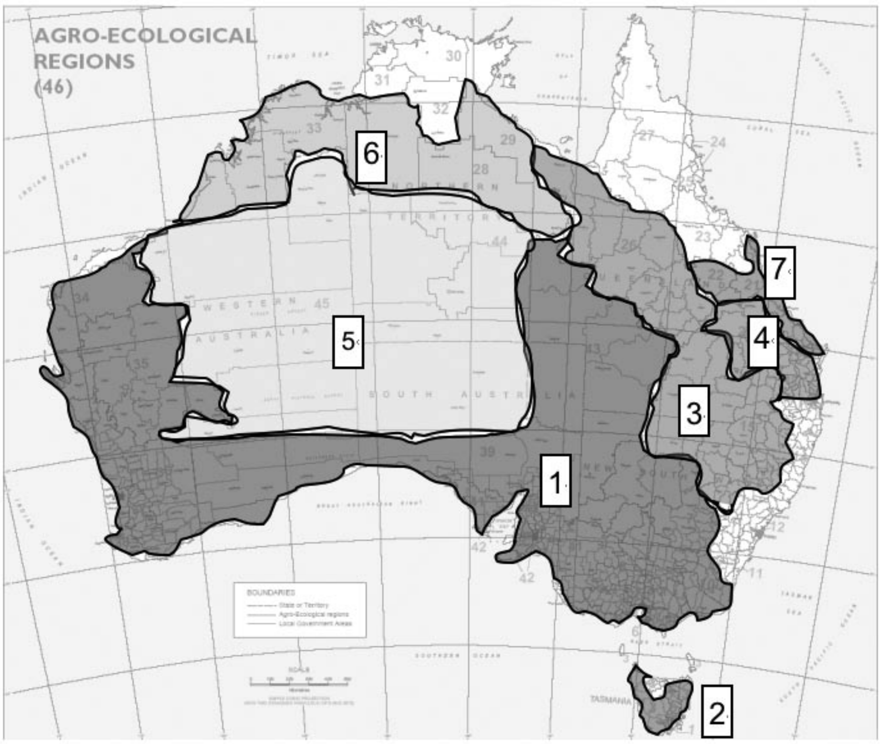
The intuition of the next step is that long-term average rainfall determines agricultural operations that are suitable for each region, while risk to farm income is related to variability around the trend in rainfall. Therefore, understanding the relationship between rainfall by regions enables diversification of climate risk by investing in regions where fluctuations from mean rainfall are uncorrelated.

Variations from long-term averages were analysed using SPSS software, and cluster analysis grouped the continent into seven principal regions that share common rainfall patterns. A number of smaller regions have their own distinctive rainfall patterns, but none has rainfall that is negatively correlated with other parts of Australia. Results are shown in Figure 2.

The second step towards constructing a diversified portfolio is to use cluster analysis to identify the strength of linkages between returns across different agricultural sectors.

These two analytical steps lead to the matrix in Table 2 that provides a diversified agricultural portfolio, with principal regions down the vertical axis and agricultural sectors across the horizontal axis. Shaded cells indicate regions where the product is not farmed or where geography is irrelevant, and proportions of the portfolio in each region and sector are roughly their share of Australian

FIGURE 2: **Correlated rainfall regions**



agricultural production. As locations and commodities are ranked so that proximity of cells in the table is a measure of their correlation, the table should be populated with quality projects spread across the cells. The result is a portfolio of agricultural investments that is naturally hedged against the risks from uncertainty in rainfall and commodity prices.

An important aspect of the portfolio, of course, is that its long-term return equals the weighted average return expected from individual projects. Although diversification reduces the uncertainty in returns, the expected return is determined solely by the performance of investments. Thus, selection of individual projects is critical and should be based around sound fundamentals. These include good management, a secure supply chain and favourable performance and pricing. To achieve reasonable scale economies, individual projects should be valued upwards of about $10–20 million, which requires a portfolio of around $200 million for reasonable diversification.

Historically, asset appreciation has been important to agricultural returns, so investment selection should take this into account. Except for small properties and those close to major cities, absolute property values have a ceiling placed on them to yield around 8% annually from operations when well managed and under optimised value. Thus, capital appreciation can only be significant when the property can be turned around or put to a more profitable use. The intensely cyclical nature of agriculture suggests that investors should adopt a vulture bias, buying into regions hit by low rainfall and farms producing commodities at a low point in their price cycle.

Another consideration in project selection comes from the fact that agriculture consumes two-thirds of Australia's reticulated water, which is a concern due to its current availability and cost. This risk can be minimised by choosing properties that operate productively using just rainfall, and avoiding water-intensive commodities such as rice and cotton.

An obvious extension of this analysis is to examine the effect of incorporating agricultural investments into a broader portfolio. Studies in Australia (Johnson, Malcolm and O'Connor, 2006) and overseas (Hardin and Cheng, 2002) confirm that correlations between returns from listed agricultural firms and other asset classes are generally well under 0.5. As a result, adding investments in agriculture to a traditional portfolio can reduce its risk.

Is agriculture a sound investment?

Historically, returns to the best-performing agricultural operations in Australia have roughly matched those from other sectors of the economy. Intuitively this is not a surprise as arbitrage would tend to close any gaps. In agriculture, about a third of investment returns are specific to projects, so these need to be chosen based on sound fundamentals and favourable valuations. Another third of returns arise in exogenous factors that bring risks from the uncertainty of climate and commodity markets, but can be naturally hedged by a suitably diversified portfolio. Given that returns from agriculture move relatively independently of other asset classes, the sector should form part of a well-diversified portfolio.

TABLE 2: **Matrix for a diversified agri-investment portfolio**

		Project Commodity												% of Portfolio
			Livestock	Cereals	Forestry	Food Processing	Fibres	Other Foods	Dairy	Fruit	Wine	Eggs	Aquaculture	
Project Location	1	Western, southern and central eastern Australia												53
	2	Tasmania, excluding Burnie												2
	3	Central NSW and central Queensland												20
	4	South-eastern Queensland, and Burnie												10
	6	Kimberley and Central Northern Territory												5
	7	Central Queensland Coast												10
Percentage of Portfolio			25	15	5	5	10	10	10	5	5	5	5	

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