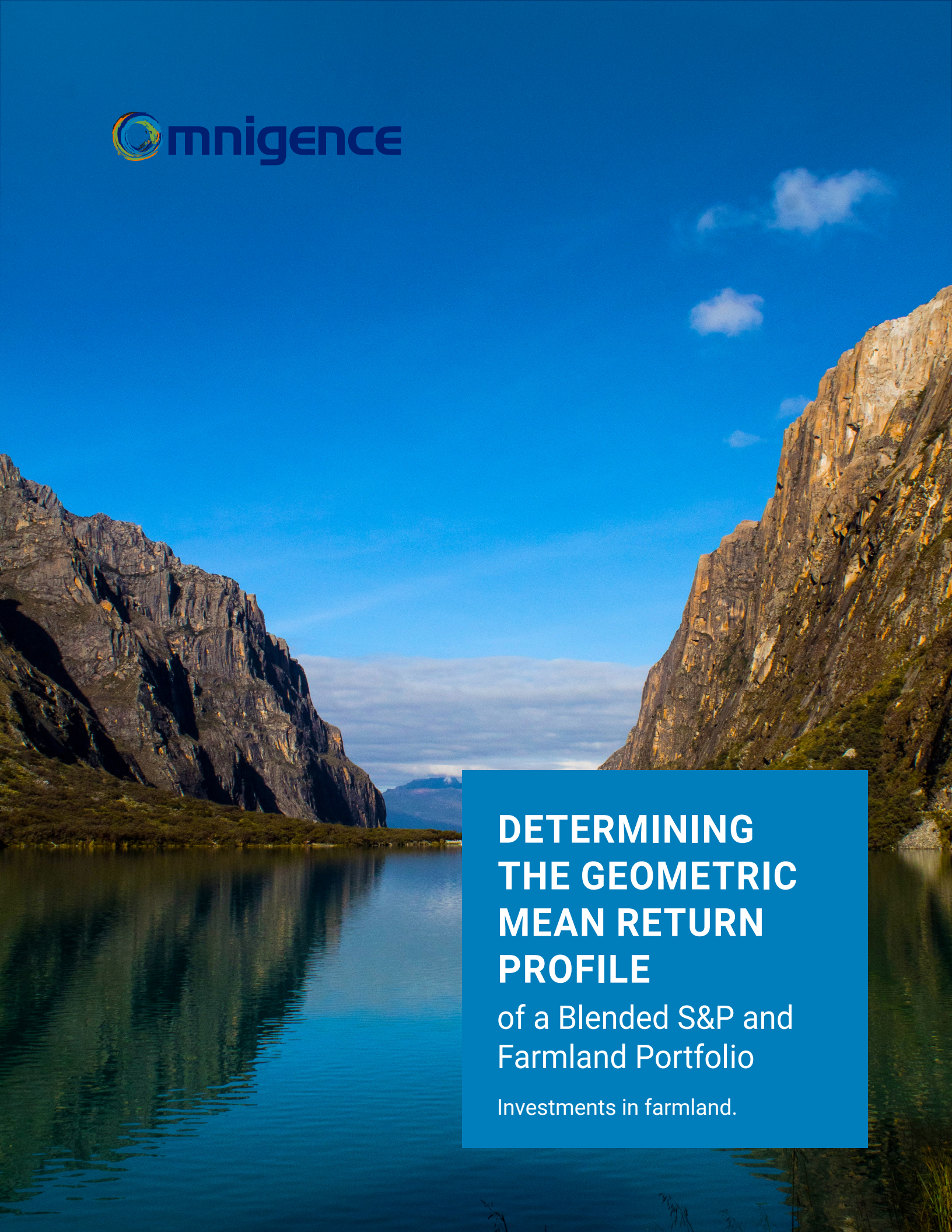

DETERMINING THE GEOMETRIC MEAN RETURN PROFILE

of a Blended S&P and Farmland Portfolio

Investments in farmland.

ABSTRACT:
Geometric mean maximization ("GMM") seeks to achieve growth of the capital invested such that the terminal wealth is maximized as opposed to maximising risk adjusted returns as measured by the Sharpe ratio. Assets described as cost effective safe havens can be colloquially described as enhancing the GMM of a portfolio across various confidence levels. Based on simplified testing on a 100% S&P portfolio, Canadian farmland weighted pursuant to Veripath's portfolio construction tool, appears to be such a safe haven at relatively modest allocation levels.

KEY WORDS:
Geometric mean maximization, Sharpe ratio, farmland, portfolio construction model, S&P, risk adjusted returns, Monte Carlo simulation


Stephen Johnston
Director – Veripath
sjohnston@omnigenceam.com


Barclay Laughland
Director – Veripath
blaughland@omnigenceam.com


Carmon Blacklock
VP Investments – Veripath
cblacklock@veripathpartners.com


Keenan Viney
Data Researcher
kviney@omnigenceam.com

GMM EXPLAINED:
Rather than re-invent the wheel, we have included two fairly standard and accepted definitions of geometric mean maximization and why it's worth considering as a portfolio construction tool over and above traditional risk adjusted return metrics (e.g. Sharpe Ratio):

> *"Academics and practitioners usually optimize portfolios on the basis of mean and variance. They set the goal of maximizing risk-adjusted returns measured by the Sharpe ratio and thus determine their optimal exposures to the assets considered. However, there is an alternative criterion that has an equally plausible underlying idea; geometric mean maximization aims to maximize the growth of the capital invested, thus seeking to maximize terminal wealth. This criterion has several attractive properties and is easy to implement, and yet it seems to have taken a back seat to the maximization of risk-adjusted returns."*

Source – Geometric Mean Maximization: An Overlooked Portfolio Approach? Javier Estrada

> *"Geometric mean returns measure the average rate at which investment returns compound over a given period of time. The geometric or compound return represents the return that is achieved through reinvestment whereas the arithmetic return is simply the average of a series of returns over a given period of time. The geometric mean will always be equal to or less than the arithmetic mean. There are a couple of reasons why the geometric mean is important in the context of retirement finances. First, for most people financial planning for retirement involves taking a sum of money and both: a) making it last, and; b) turning it into income. The compounding effects reflected in geometric mean returns are the primary driver of the terminal wealth that is the basis of retirement finances. Second, the volatility of returns is the key factor in the difference between geometric returns and arithmetic returns… Consider, for example, the person who invests $100 and has a 100 percent return during year 1 followed by a 50 percent loss during year 2. This person's arithmetic return is 25 percent, while the geometric return over the same period is actually zero (start with $100, double to $200 after the first year, then back to $100 after the 50 percent loss during the second year). Which return is more relevant for the person who will be spending whatever money is there at the end of the investing period? Also note how hazardous volatility is to compound performance… Geometric mean maximization is simply a focus on maximizing the geometric mean or the growth rate of money that is invested. Geometric mean maximization should be considered highly relevant to anyone who is concerned about the amount of actual funds available after a period of saving and investing."*

Source - Investopedia

> *"Liberty means responsibility. That is why most men dread it."*
> — George Bernard Shaw

HOW TO PERFORM GMM ANALYSIS:

The tool used to perform GMM analysis is Monte Carlo simulation. Forward portfolio returns are modelled under various asset allocation configurations using historical return data for each portfolio asset. Large volumes of iterations can be run to produce a distribution of expected future geometric return.

> *"Monte Carlo Simulation, also known as the Monte Carlo Method or a multiple probability simulation, is a mathematical technique, which is used to estimate the possible outcomes of an uncertain event. The Monte Carlo Method was invented by John von Neumann and Stanislaw Ulam during World War II to improve decision making under uncertain conditions. …Since its introduction, Monte Carlo Simulations have assessed the impact of risk in many real-life scenarios, such as in artificial intelligence, stock prices, sales forecasting, project management, and pricing."*
>
> *Source: IBM Cloud Education*

> *"Both optimists and pessimists contribute to society. The optimist invents the aeroplane, the pessimist the parachute."*
> — George Bernard Shaw

GMM MODELLING METHODOLOGY:

INPUTS:

- Annual total S&P return data from 1970 to 2020 (total return with dividends)
- Annual Canadian farmland appreciation by province from 1970 to 2020 (ex-rents)
- Provinces aggregated into a single Canadian holding according to Veripath's model portfolio factor weightings
- Farmland added to the 100% S&P portfolio at values ranging up to 9.09%

PARAMETERS:

- 25-year forward holding period for S&P
- Random sample of 50 years of return data for the S&P and farmland to generate 25 years forward geometric return paths
- 1,000,000 iterations per farmland allocation
- 10 cases, 1,000,000 iterations each, 25 years = 250 million paths simulated

RESULTS:

At ~4% of the total portfolio, a Canadian farmland holding (weighted according to Veripath's model portfolio factors) increased the mean, median, 5th percentile, 50th percentile and 95th percentile returns compared to simply the 100% S&P portfolio. The biggest improvement was in the 5th percentile return as farmland tended to be most effective at improving downside returns, although while still enhancing mean and upside outcomes (i.e. downside and upside increases). The 5th percentile absolute change in terminal value was ~6%.

CONCLUSION:

Based on this simplified analysis, Canadian farmland could not be discounted as a cost-effective safe haven in that it increased the geometric mean return over the 25-year forecast period at all relevant levels of return in this simulation. Further analysis would be warranted.

APPENDIX A: DATA TABLES

Geometric 25 year forecast return to SP Portfolio

FL in Portfolio	Mean	Median	5th Percentile	50th Percentile	95th Percentile	Terminal Change in NW Median	Terminal Change in NW 5th
0.00%	10.85%	10.95%	4.80%	10.95%	16.59%	0.00%	0.00%
0.99%	10.87%	10.95%	4.90%	10.95%	16.56%	0.35%	2.50%
1.96%	10.88%	10.94%	4.98%	10.95%	16.54%	0.52%	4.40%
2.91%	10.88%	10.94%	5.05%	10.94%	16.51%	0.61%	6.22%
3.85%	10.88%	10.93%	5.12%	10.94%	16.48%	0.66%	7.91%
4.76%	10.88%	10.92%	5.18%	10.93%	16.45%	0.68%	9.44%
5.66%	10.88%	10.90%	5.23%	10.92%	16.42%	0.67%	10.83%
6.54%	10.88%	10.89%	5.28%	10.90%	16.40%	0.64%	12.19%
7.41%	10.88%	10.88%	5.33%	10.89%	16.37%	0.59%	13.48%
8.26%	10.88%	10.86%	5.38%	10.88%	16.36%	0.59%	14.76%
9.09%	10.87%	10.85%	5.42%	10.85%	16.34%	0.46%	15.94%

Table 1: Monte Carlo Results @ S&P 100% Portfolio

Mean	10.85%	Percentile	Value
Number of Trials	1,000,000	0%	-7.31%
Standard error	0.004%	5%	4.80%
		10%	6.19%
Minimum	-7.31%	15%	7.12%
Maximum	25.25%	20%	7.85%
Median	10.95%	25%	8.48%
Range	32.55%	30%	9.03%
		35%	9.54%
Standard Deviation	**3.59%**	40%	10.02%
Variance	0.13%	45%	10.49%
		50%	10.95%
Skewness	-0.15	55%	11.40%
Kurtosis	2.99	60%	11.85%
		65%	12.32%
		70%	12.81%
		75%	13.33%
		80%	13.92%
		85%	14.58%
		90%	15.41%
		95%	16.59%
		100%	25.25%

Table 2: Monte Carlo Results @ S&P plus 4% Farmland Portfolio (3.85% of total)

Mean	10.88%	Percentile	Value
Number of Trials	1,000,000	0%	-3.67%
Standard error	0.003%	5%	5.12%
		10%	6.39%
Minimum	-3.67%	15%	7.25%
Maximum	47.84%	20%	7.95%
Median	10.93%	25%	8.54%
Range	51.51%	30%	9.07%
		35%	9.56%
Standard Deviation	**3.46%**	40%	10.03%
Variance	0.12%	45%	10.49%
		50%	10.93%
Skewness	-0.03	55%	11.37%
Kurtosis	3.01	60%	11.81%
		65%	12.27%
		70%	12.75%
		75%	13.26%
		80%	13.83%
		85%	14.49%
		90%	15.30%
		95%	16.48%
		100%	47.84%

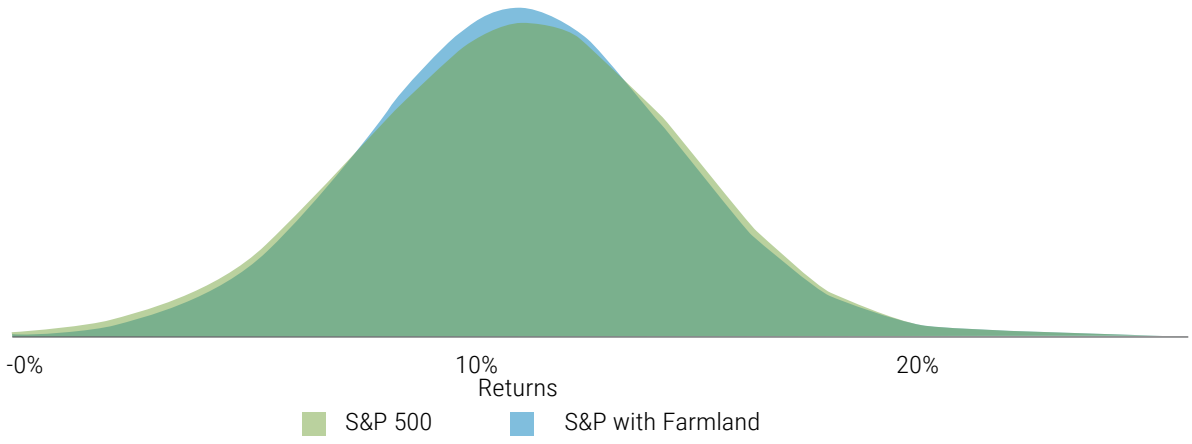

Table 3: Veripath Factor Weighted Portfolio Model

Regulatory environment (Investor permitted)	AB Yes	ON Yes	MB Yes	SK Yes	QC Yes	NS Yes	NB Yes	BC Yes	PE Yes	NL Yes
Average productivity adjusted wheat pricing (<$2,500/tonne)	1		1	1						
Average productivity adjusted wheat pricing ($3,500/tonne => X => $2,500/tonne)					1					
Average productivity adjusted wheat pricing (> $3,500/tonne)						1	1	1	1	1
Farmland sharpe ratio (>0.75, <=1.25)		1	1		1					1
Farmland sharpe ratio (>1.25, <=1.5)				1		1				
Farmland sharpe ratio (>1.5)	1									
Correlation to inflation (1970s = >0.3, <=0.4)	1	1	1	1	1	1	1	1	1	1
Correlation to inflation (1970s = >0.4, <=0.5)										
Correlation to inflation (1970s = > 0.5)										
Up/down ratio (< 1 down year in last 25 years)	1	1	1	1	1	1	1	1	1	1
Up/down ratio (< 3 >= X down years in last 25 years)										
Up/down ratio (> 3 down years in last 25 years)										
Raw acre size as a percent of Canada total (>5%)	1	1	1	1	1					
Market turnover (>$2B pa)	1	1		1				1		
Percent operators also cash renters (>50%)	1			1						
Annual growth in average farm size (>1%)	1			1						
Farm leverage (<20%)	1	1		1	1					
Crop composition (field crops >75%)	1	1		1						

Regulatory environment (Plans permitted)	Weighting (0-5)	AB Yes	ON Yes	MB Yes	SK Yes	QC Yes	NS Yes	NB Yes	BC Yes	PE Yes	NL Yes
Average productivity adjusted wheat pricing (<$2,500/tonne)	5	5	0	5	5	0	0	0	0	0	0
Average productivity adjusted wheat pricing ($3,500/tonne => X => $2,500/tonne)	4	0	0	0	0	4	0	0	0	0	0
Average productivity adjusted wheat pricing (> $3,500/tonne)	0	0	0	0	0	0	0	0	0	0	0
Farmland sharpe ratio (>0.75, <=1.25)	3	0	3	3	0	3	0	0	0	0	3
Farmland sharpe ratio (>1.25, <=1.5)	4	0	0	0	4	0	4	0	0	0	0
Farmland sharpe ratio (>1.5)	5	5	0	0	0	0	0	0	0	0	0
Correlation to inflation (1970s = >0.3, <=0.4)	3	3	3	3	3	3	3	3	3	3	3
Correlation to inflation (1970s = >0.4, <=0.5)	4	0	0	0	0	0	0	0	0	0	0
Correlation to inflation (1970s = > 0.5)	5	0	0	0	0	0	0	0	0	0	0
Up/down ratio (< 1 down year in last 25 years)	5	5	5	5	5	5	5	5	5	5	5
Up/down ratio (< 3 >= X down years in last 25 years)	4	0	0	0	0	0	0	0	0	0	0
Up/down ratio (> 3 down years in last 25 years)	3	0	0	0	0	0	0	0	0	0	0
Raw acre size as a percent of Canada total (>5%)	2	2	2	2	2	2	0	0	0	0	0
Market turnover (>$2B pa)	2	2	2	0	2	0	0	0	2	0	0
Percent operators also cash renters (>50%)	1	1	0	0	1	0	0	0	0	0	0
Annual growth in average farm size (>1%)	3	3	0	0	3	0	0	0	0	0	0
Farm leverage (<20%)	2	2	2	0	2	2	0	0	0	0	0
Crop composition (field crops >75%)	1	1	1	0	1	0	0	0	0	0	0
Raw Score	(A)	29	18	18	28	19	12	8	10	8	11
Raw Acres	(B)	52	13	19	64	8	1	1	7	1	0.07
Matrix adjusted acre weight	(A/C x B/D)	0.06	0.01	0.01	0.07	0.01	0.00	0.00	0.00	0.00	0.00
Simple acre weighted portfolio (% acres)	(B/D)	31.3%	7.8%	11.4%	38.5%	4.8%	0.6%	0.6%	4.2%	0.6%	0.0%
Matrix adjusted portfolio (% acres)	(A/C X B/D)/(E)	36.5%	5.7%	8.3%	43.4%	3.7%	0.3%	0.2%	1.7%	0.2%	0.0%
Target Market Size (millions acres)	166	52	13	19	64	8	1	1	7	1	0.07

Toronto Office:
TD Canada Trust Tower, 161 Bay St.
27th Floor, P.O. Box 508
Toronto, ON, M5J 2S1

Calgary Office:
Suite 300, 4954 Richard Road SW
Calgary, AB, T3E 6L1

www.veripathpartners.com