INCENTIVIZING FARMLAND INVESTMENTS: EXPANDING ON AN EVALUATION OF PORTFOLIO PERFORMANCE WHEN INCORPORATING AGRICULTURAL INVESTMENTS

by

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ABSTRACT

MATTHEW MORRILL. Incentivizing farmland investments: expanding on an evaluation of portfolio performance when incorporating agricultural investments. (Under the direction of DR. CRAIG DEPKEN)

Farmland investments have shown to have remarkably high returns when added to a portfolio for diversification. Previous research shows a trend of the continuous growth in the amount invested in farmland as a fraction of a well-diversified portfolio. The study replicates methodology used in Hennings, Sherrick, and Barry (2005) to determine portfolio performance adding ten years of new data. Farmland investments again prove to be a worthwhile addition to a portfolio of traditional assets. The research indicates that at higher levels of return, farmland begins to take over a portfolio, suggesting that it is a low-risk, high-reward investment.

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INTRODUCTION

Absent from the traditional investment strategy that investors and wealth planners typically execute is making purchases within real asset classes. When real assets are excluded from a portfolio there is an elevated chance that the portfolio will be risk-inefficient. This is in defiance to the principle that a rational investor would seek to maximize return while simultaneously limiting risk.

Diversification is an integral process for wise investors in general investments such as stocks and bonds. Diversification benefits a portfolio by spreading risk across a basket of investments. Given the recent rise in the performance of real estate investments, investors and portfolio managers have begun to consider adding real estate to their funds. Farmland is a subset of this larger real estate group and can also add significant value and diversification to any portfolio.

A significant body of research has been developed highlighting the benefits of farmland investments within a portfolio. Yet farmland investments still do not appear as prevalent in diversified portfolios as more traditional assets. In a study authored by Hennings, Sherrick, and Barry (2005), the researchers generalized "the analysis of farmland investments in institutional portfolio".

The current study replicates the methodology used by Hennings et al. (2005) but adds ten years of new data, from 2006-2015 from the original set (1969 to 2005). This study intends to demonstrate that with additional data, including farmland assets in a portfolio will still yield a higher rate of return at a lower level of risk when compared to a portfolio without farmland assets.

LITERATURE REVIEW

When diversifying a portfolio, there are many assets from which to choose. Traditional asset portfolios tend to contain stocks, bonds, and business real estate. However, with just over 40% of U.S. land considered farmland, agricultural investments should be considered as a major, instead of minor, asset (Census of Agriculture Highlights, 2012). Lins, Sherrick, and Venigalla (1992) make a case for farmland and its role in maximizing the total performance of institutional portfolios where stocks, bonds, and business real estate prevail. Most academic journal articles focus their attention on farmland's impact on portfolio returns, diversification and the risk associated with investing in farmland as an asset class. Lins, et al. (1992) find, "it is evident that farmland in many states had both a higher return and a lower standard deviation of return than the S&P 500 and long-term corporate bonds." This evidence is contrary to typical contention that the rates of return on farmland is substantially lower than traditional asset portfolios. Irwin, Forster, and Sherrick (1988) state that "over long periods of time, risk adjusted returns to farm real estate may have been relatively high, not low, as is commonly perceived." It is because of these returns that farmland is included in a majority of efficient portfolios with higher than typical weights.

It comes as no surprise that interest in farmland investments has increased in recent years, since farmland investments result in high returns (Sherrick, Mallory, and Hopper 2012). However, it isn't always easy to invest in farmland assets. Barriers to investment in farmland real estate are underscored by the difficulties associated with direct investment. The reasons are twofold. One, there is a high price tag for direct investment in farmland. Two, there is no market exchange for farmland investment. It is for these reasons most farmland investment is conducted at the institutional level. Sherrick et al. (2012) go on to say:

> “in virtually every case across the majority of periods examined, and under the bulk of the characterizations of returns, the summary message has been that farmland compares favorably with most other common asset classes both in actual returns measures, relative risk, and in terms of the diversification benefits offered by its low correlation with other financial assets and its inflation hedging potential.”

Painter (2013) underscores the above statement in his paper on the inclusion of certain assets in an investment portfolio by concluding the answer to the question, “can traditional investors improve financial performance by adding a farmland real estate trust, gold, and oil to their investment portfolios?” Painter (2013) found that farmland real estate investment trusts (F-REITs), gold, and oil were added to a portfolio of traditional investments, “financial performance was significantly improved”.

Chen, Wilson, Larsen, and Dahl (2014) contributed an article analyzing the role of farmland and other agricultural investments in class-specific portfolios. In their model, the S&P futures did not enter the portfolio. This could imply that farmland assets have outperformed this particular broader market index.

Diversification and risk is discussed frequently in farmland investment literature. Investors use diversification to spread risk over a portfolio. Irwin, et al. (1988) found that farm real estate returns are “negatively correlated with most fixed income securities…and have near-zero correlation with common stocks.” Farmland investments appear to have a remarkable way of reducing risk in well-diversified portfolios as “negative correlation coefficients between farm real estate and most other assets” are found (Irwin et al., 1988).

Sherrick et al. (2012) echoes this conclusion by finding that farmland has shown both a low or negative correlation with investments such as stocks and bonds while also having a positive correlation with inflation and PPI. Sherrick et al. (2012) find that “farmland becomes the majority asset” when portfolios attempt higher return-risk combinations. Supplemental detail into the correlation of farmland investments and traditional investments along with its correlation to inflation is summarized by Painter (2013), who confirms that F-REITs are negatively correlated with REITs and every stock market. Painter (2013) also finds a low correlation with fixed income assets. Sherrick et al. (2012) shows that these negative correlations can reduce portfolio risk by including assets that move opposite to one another. Furthermore, Painter (2013) points to F-REIT’s positive correlation with inflation. Lins et al. (1992) draws the same conclusion: “the high positive correlation with inflation makes farmland an important hedge against inflation.”

Various papers have stated that farmland adds tremendous value to a portfolio. It has been shown that agriculture investment is comparable, and often better, than gold and oil as a hedge against inflation. Farmland can be a good tool for risk-averse investors to seek higher than normal returns at a reduced level of risk.

Implications of Farmland Investment

Research suggests that farmland investors, which include farmers, should, in addition to their farmland, own a basket of traditional investments that includes stocks, bonds, oil, and REITs as a compliment to their overall portfolio. The benefit to non-farmer investors and institutional investors is more options in asset choices that provide exceptional diversification while keeping up with inflation. Painter (2013) explains that farmland investment is beneficial to both active and retiring farmers, as “institutional investors and larger pension funds can consider the diversification benefits of holding F-REITs as part of their portfolios.” Painter (2013) identifies a primary effect of farmland investment: to supply new capital through the purchase of farmland from those farmers who are retiring and in turn renting the farmland to new farmers and those who are looking to expand their current operations.

Expansion of agriculture investment has significant impacts on farm businesses. The growth of F-REITs has the potential to feed itself, leaving a smaller number of even larger farms. This could result in fewer farm owners creating more demand for equity investment into farmland, implying further growth in F-REITs. Painter (2013) describes the conditions that lead to this growth:

> “The demand for F-REITs by the farm business sector depends, at least partially, on the speed at which average farm size is expected to grow. If cropping and machinery technological changes continue to replace labour with machines and larger farm sizes are needed to achieve economies of scale associated with those technological investments, the internal equity generated by farmers may not be sufficient to finance those farm expansions.”

Conversely, if the rate of technological change were to occur at a pace at which farmers were able to achieve equity financing on their own, the expansion of F-REITs would dwindle and demand for these products would not materialize (Painter 2013).

Yet to be addressed is how farming communities would be affected by such investments. The question arises: how might farmers' cultural and social habits change as a result of outside investors and institutions owning most of the farmland? Painter (2013) advances this thought and poses an additional question: how might farmers react to foreigners owning much of their farmland? Furthermore, given the expected growth in farmlands, is there an adequate supply of farm managers to run farms most effectively?

Arriving at Institutional Farmland Investment

Chen et al. (2014) describe institutions that have a focus on agricultural investment. Organizations explicitly invested in farmland include TIAA-CREF, Hancock Agricultural Investment, and CERES—a non-profit focused on sustainability in business practices. In addition to these large firms, a plethora of funds have risen with a concentration on venture capital within agriculture (Chen et al., 2014). These firms face many decisions in selecting farmland for investment: most important is the type of land and the crops that can be sustained on a particular farm. Weather patterns and culturally significant activities of the region also play a significant role in the decision-making process. Lins et al. (1992) explains that beyond nature, "other factors such as industrial development and policy decisions of the local/state governments also play a significant role in returns on farmland."

Across the United States, a tendency towards urbanization led to large farmland values, but also to low cash rents on farmland compared to its overall value. This created disparity in returns to farmland over different regions. However, through diversifying, the nature of agriculture investment volatility can be mitigated via investment over contrasting geographic zones. Lins et al. (1992) describe how institutions choose types of farmland to invest in:

> “These brokers identify target properties for purchase with the portfolio manager providing ‘due diligence’ in the selection process. Once properties are acquired, the portfolio manager relies on the local brokers/farm managers to find tenants and to manage the property. Most farmland properties are based upon an annual cash rental arrangement.”

The characteristics describing farmland investment make this an attractive alternative for institutional investors. The vast majority of economic literature points out that there are only a few players in the realm of agriculture investment. Ownership of farmland by these entities represent a very small amount of farmland in the United States despite the total value of all United States farm real estate surpassing $2.4 trillion and accounting for 82% of all the wealth of the American farm sector (USDA-ERS, 2015). Farmland represents two fifths of United States’ 915 million acers (USDA, 2014). Due to the abundance of farmland, there is ample opportunity for institutions to select the most productive and profitable farmlands for its investors.

Armed with the knowledge that agriculture investments are quickly becoming a target of interest for institutional investors, Hennings, Sherrick, and Barry (2005) examined the influence of farmland investments on the risk-efficiency of mixed asset portfolios. This research indicated that farmland significantly enhanced risk-efficiency by comparing traditional asset classes to state-level unleveraged farmland returns. The traditional asset classes Hennings et al. (2005) included are: equity market indices, commercial REITs, corporate bonds of varying grades, government bonds and treasuries, US equities indices, interest rate indexes, and commodity investments.

This paper expounds upon the research of Hennings et al. (2005) by replicating the methodology used but adds ten years of new data, from 2006-2015. The intent is to show that by including farmland assets in a portfolio, you can still achieve a higher rate of return at a lower level of risk.

METHODOLOGY & MODEL SPECIFICATION

As a replication of the 2005 study by Hennings et al., the methodology has been followed exactly for analysis. The researchers' method section is described below.

Risk Return and Efficient Portfolio Frontier

The E-V proficiency model is a frontier on a curve that represents the ratio of risk to return. It is used to "obtain the allocations of assets that define portfolios on the risk-efficient frontiers" (Hennings et al., 2005). Use of this model benefits investors as they seek to build a risk-efficient portfolio. The approach is described below by Hennings et al. (2005):

> "…allocate investment so that the variance of the portfolio is minimized subject to the constraint that the expected return of the portfolio equals a given value, and then parametrically vary this constraint to trace out the frontier."

For the purpose of this replication, two assets will be considered. Knowledge of the variance and covariance of all assets under consideration are necessary to solve this problem (Hennings et al., 2005).

Hennings et al. (2005) state the case for two assets below:

> "Let R_1 and R_2 be the return to two different assets and let "α" be the fraction of wealth in asset 1. The respective expected values and variances on assets 1 and 2 are represented by $E(R_1)$, $var(R_1)$ and $E(R_2)$ and $var(R_2)$. Then the problem is to choose "α" to minimize the portfolio variance, subject to the constraint that $E\,(Rp) = m$ where m is some target set, say for example 15 percent. For two assets, the expected return and variance of the return for the portfolio can be defined as:

(1.) $E(Rp) = \alpha * E(R_1) + (1-\alpha) * E(R_2) = m$

and

(2.) $\text{var}(Rp) = \alpha^2 * \text{var}(R_1)^2 + (1-\alpha)^2 * \text{var}(R_2)^2 + 2 * \alpha * (1-\alpha) * \text{cov}(R_1, R_2)$

In other words, the problem stated above is equivalent to solving:

(3.) $\text{Min} \{\text{var}(R_p) = \alpha^2 * \text{var}(R_1)^2 + (1-\alpha)^2 * \text{var}(R_2)^2 + 2 * \alpha * (1-\alpha) * \text{cov}(R_1, R_2)\}$

subject to the constraint

(4.) $\alpha * E(R_1) + (1-\alpha) * E(R_2) = m$

Hennings et al. (2005) use matrix notation to generalize the problem:

$\text{Min}_\omega \{\text{var}(R_p) = \omega' \sum^{\omega}\}$

(5.) $st.\ \omega' * E(R_p) = m$

Hennings et al. (2005) describe the matrix notation above: "ω represents a vector of the fractions of wealth assigned to each test and Σ is the variance-covariance matrix of the portfolio." If assets are perfectly positively correlated ($p = 1$), the portfolio frontier is an upward sloping straight line. Conversely, if assets are perfectly negatively correlated ($p = -1$), the portfolio frontier is a downward sloping straight line. A hyperbola exists between these two straight lines when the correlation among assets is lower than one ($-1 < p < 1$). Table 1 depicts each of these portfolio frontiers.

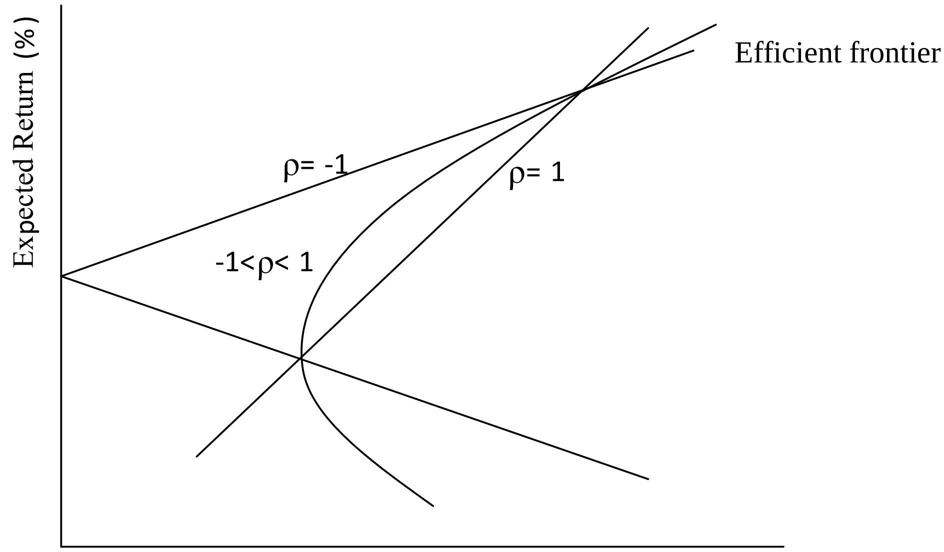

Figure 1: Efficient Portfolio Frontier Risk (%)

Note: Adapted from *Portfolio Diversification Using Farmland Investments*, p.8, by E. Hennings, B.J. Sherrick, and P.J. Barry (2005).

The E-V return-risk analysis used in this case is valid when at least one of two conditions are met. One, that returns must be elliptically distributed, meaning that all moments on the distribution are “fully characterized by the mean and variance of the returns” (Balvers in Hennings et al., 2005). Two, that investors disregard the distribution in such cases that higher moments characterize returns because of the investor’s use of quadratic utility functions in determining their portfolio (Hennings et al., 2005). Hennings et al. (2005) state that “gains in risk efficiency can come from either reduction in risk at a given level of return, or increases in returns at a given level of risk”. To evaluate the risk-efficiency of a chosen portfolio, you must calculate the risk-return ratio of an alternative portfolio simultaneously (Hennings et al., 2005). To consider reductions in risk and increases in returns simultaneously, Sharpe’s ratio is used. Sharpe’s ratio is defined as “the ratio of the difference between portfolio return and the riskfree asset return to the standard deviation of the portfolio’s return”. Once Sharpe’s test values are identified, portfolio-dependent Sharpe ratios are inserted into an F-test formula and can be used to evaluate "the differences between two portfolios mean-variance efficiencies" (Hennings et al., 2005). Below is the F-test by Gibbons (1989) which is utilized by Hennings et al. (2005):

(6.) $$F = \frac{T(T-n-1)W}{N(T-2)}$$

where

(7.) $$W = \left[\frac{\sqrt{1+S_i^2}}{\sqrt{1+S_j^2}} \right]^2$$

Hennings et al. (2005) describe the F-test formula:

"*T* is the number of observations, *Sj* is the Sharpe ratio for portfolio *j*, and *n* refers to the number of investment opportunities available. The null hypothesis that the optimal portfolio is not more efficient than the alternative portfolio under a mean-variance criterion."

Using STATA, the mvport function was used to determine weights for every asset in the portfolio. The "noshort" function was added to this code to exclude shorting of any assets in the portfolio. Thus, only traditional investments and farmland would remain.

RESULTS

Traditional & Farmland Assets

The information utilized as a part of this study comprise of returns for various asset classes and different individual returns series inside every asset class. Included asset classes are government securities (T-10y), basic stocks (Dow Jones, S&P500 and NASDAQ), corporate securities (Baa, Aaa, CD3M), financing costs determined by the London interbank offered rate (BBALibor); real estate investment trusts (Equity, Mortgage and ALL REIT's), and commodity indices (Reuters, Commodity Research Bureau [CRB] Spot and Futures). Farmland portfolios by state (California, Colorado, Montana, New Mexico, Illinois, Indiana, Iowa, Missouri, Florida, Tennessee, Virginia, New York, Louisiana, Mississippi). The date range for information regarding each variable covers the period from 1969 through 2015 (NASDAQ beginning 1985, All REIT's/Equity REIT's beginning 1972). However, in a majority of the cases, the observable data are recorded monthly. In this paper all returns have been transformed to annual figures. Table 1 depicts the mean yearly returns, standard deviation and the minimum and maximum values for the traditional and farmland assets. While inspecting this table the traditional assets NASDAQ, Equity REIT's, and All REIT's demonstrate the most noteworthy mean returns. The farmland states with the highest average returns was Colorado, Montana, Illinois, Indiana, Iowa, Missouri, Tennessee, New York, and Mississippi. BBALibor, T-10y and Baa have the least standard deviation for the period being reviewed. For the same period Colorado, Tennessee and New York have the lowest standard deviation.

Table 1: Descriptive Statistics of the Data

Portfolio Level Data

Variable	Desc	Obs	Mean	Std Dev	Min	Max
S&P500	Equity Index	56	0.064	0.163	-0.49	0.29
Dow Jones	Equity Index	56	0.058	0.154	-0.41	0.32
Nasdaq	Equity Index	31	0.097	0.260	-0.52	0.62
Equity REITs	Real Estate Investment Trust	45	0.111	0.174	-0.47	0.39
Mortgage REITs	Real Estate Investment Trust	45	0.047	0.278	-0.60	0.57
All REITs	Real Estate Investment Trust	45	0.091	0.207	-0.55	0.40
BBALibor	Interest Rates	30	0.040	0.028	0.00	0.09
CD3M	Bonds	51	0.056	0.035	0.00	0.16
T- 10y	Bonds	47	0.067	0.029	0.02	0.14
Baa	Bonds	56	0.083	0.028	0.05	0.16
Aaa	Bonds	56	0.073	0.026	0.04	0.14
Reuters	Commodity Index	50	0.033	0.163	-0.40	0.60
CRBSpot	Commodity Index	50	0.029	0.122	-0.27	0.45
CRBFI	Commodity Index	50	0.032	0.129	-0.27	0.39
California	Farmland	47	0.093	0.076	-0.06	0.32
Colorado	Farmland	47	0.126	0.069	-0.06	0.29
Montana	Farmland	47	0.119	0.095	-0.22	0.44
New Mexico	Farmland	47	0.094	0.086	-0.06	0.29
Illinios	Farmland	47	0.105	0.097	-0.22	0.37
Indiana	Farmland	47	0.109	0.094	-0.14	0.36
Iowa	Farmland	47	0.125	0.116	-0.25	0.38
Missouri	Farmland	47	0.120	0.083	-0.16	0.35
Florida	Farmland	47	0.075	0.090	-0.05	0.50
Tennesse	Farmland	47	0.096	0.067	-0.04	0.25
Virginia	Farmland	47	0.086	0.081	-0.09	0.29
New York	Farmland	47	0.079	0.056	-0.01	0.27
Louisiana	Farmland	47	0.096	0.085	-0.22	0.27
Mississippi	Farmland	47	0.115	0.086	-0.08	0.33

The land values information for the year 1969 to 2015 were acquired from the National Agricultural Statistics Service (NASS). Cash rent evaluations were gotten from the USDA Economics and Statistics System for the same period. To figure the yearly returns they were computed by including cash rents and capital gains as a percentage of land value, and subtracting property taxes as a rate for farmland real estate. For the purpose of this paper it is a prerequisite to assume that farmland and crop land appreciation rates are the same. While looking at the yearly returns (Table 1), it is obvious that the cropland returns are very comparable between states. Most of the states have, all things considered, exceptional yields on cropland and a moderate standard deviation.

Evidence to support the inclusion of farmland investments in a diverse portfolio is found when solely testing investment on traditional assets (stocks, bonds, and the most frequently used real estate indices) within this data set. Table 2 demonstrates the ideal portfolio weights utilizing traditional assets. Nine out of the twenty-eight assets from table 1 enter the frontier. The rate of return with the highest standard deviation happens when 100% of resources are put into the NASDAQ with a return of 11.1% and a standard deviation of 26%. As the risk and return are decreased, BBALibor, Baa and CRBFI enter the portfolio. Similarly, in this way Mortgage REIT's, CRBSpot enter as well. The lowest standard deviation portfolio comprises of interests in six assets, and permits the investors to make a 6.6% normal yearly return with a volatility of 2.2%. The NASDAQ Index and Baa bonds stay in the portfolio at all levels of return but the final three return levels where everything is invested in the NASDAQ. BBALibor and Baa prevail over the portfolio for lower risk levels up to 7.7% of risk return. At the higher level of risk and return portfolios are dominated by NASDAQ and Baa bonds. Portfolios constructed with a return of 9% or less are better off than the naive portfolio, which contains equal weights of each asset. As the standard deviation rises with returns greater than 9.0% the naive portfolio is better positioned.

Table 3 includes 14 states that were considered for the farmland only portfolio. Seven states entered in the ideal portfolio. Despite the fact that three states from the Mountain Region entered the portfolio, there is not a geographic strength in the outcome as the ideal frontier incorporates interests in four distinctive geographic territories. The greatest expected return is achieved when 94.4% of the portfolio’s resources are put into Colorado and 5.6% in Montana where output valuation is focused in grains, oil-seeds, dry beans, and dry peas (Hennings et al.,2005). The yearly return is 10.1% with a standard deviation of 24.9%. As the normal return and risk are reduced, California and Tennessee enter the portfolio, and afterward New York. These three states vary from the Mountain States in geographic area and agriculture production. California, Tennessee, and New York agriculture is primarily focused on nursery, greenhouse, floriculture, sod, fruits, tree nuts, and berries (Hennings et al, 2005). The most ideal return (highest return with the lowest standard deviation) utilizing those five states where standard deviation is minimized is 6.6% with a volatility of 2.2%.

Previously, isolated farmland investment portfolios and isolated traditional asset portfolios were considered. Hereafter, the paper will focus on the impact of land investment on a blended asset portfolio utilizing cropland returns.

Cropland has a low or negative correlation with different assets suggesting a reduction of risk is possible when incorporating cropland returns in a blended portfolio (Hennings et al., 2005). Table 4 demonstrates the ideal portfolio when cropland returns are permitted to compete with traditional assets with no limitation to the weight given to any asset in the portfolio. The greatest risk to return of 13.2% with a standard deviation of 9.5% was achieved when putting 100% in cropland, specifically in Montana. This is the only portfolio not containing at least one traditional asset. As the target return is reduced, S&P500, North American equity index, BBALibor, Baa bonds, CRBSpot, New York, and Louisiana are added to the portfolio. The minimum risk and return portfolio is constructed of 15.1% farmland and 84.9% traditional investments. This portfolio is weighted towards BBALibor and Baa bonds. For lower levels of risk crop land is included in portfolios that contain mostly traditional investments. At higher levels of risk the concentration of a portfolio begins to move towards mostly farmland.

Table 2: Efficient Portfolio- Traditional Assets

	Portfolios														Naïve
E(Rp)	5.6	5.9	6.3	6.6	7.0	7.3	7.7	8.3	8.7	9.0	9.7	10.1	10.4	11.1	6.7
St. Dev.	2.2	2.2	2.2	2.2	2.3	2.4	2.5	2.6	2.9	6.3	18.0	24.9	26.0	26.0	6.3
NASDAQ	0.5	0.5	0.6	0.7	0.8	0.9	2.8	22.7	69.3	95.9	100.0	100.0	100.0	100.0	9.1
Equity REITS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
Mortgage REITs	1.5	1.5	1.3	1.0	0.7	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
BBALibor	55.8	50.0	42.0	36.0	28.2	22.2	14.2	1.9	0.0	0.0	0.0	0.0	0.0	0.0	9.1
CD3M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
BAA	34.0	40.4	49.0	55.5	64.1	70.5	79.1	92.0	97.2	77.3	30.7	0.0	0.0	0.0	9.1
Reuters	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
CRBFI	6.7	6.5	6.3	6.1	5.9	5.7	5.5	5.2	0.0	0.0	0.0	0.0	0.0	0.0	9.1
CRBSpot	1.5	1.3	1.1	1.0	0.8	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1

Table 3: Efficient Portfolio when Assets Classes are Restricted to Cropland - 50% Upper Quantile of Production Values

	Portfolios												Naïve
E(Rp)	5.6	5.9	6.3	6.6	7.0	7.3	7.7	8.3	8.7	9.0	9.7	10.1	11.2
St. Dev.	2.2	2.2	2.2	2.2	2.3	2.4	2.5	2.6	2.9	6.3	18.0	24.9	5.1
California	13.6	12.5	11.4	10.3	9.3	8.2	7.1	6.0	4.9	3.8	1.4	0.0	14.3
Colorado	47.3	51.1	55.0	58.9	62.7	66.6	70.4	74.3	78.2	82.1	87.3	94.4	14.3
Montana	5.7	5.8	5.9	6.1	6.2	6.3	6.5	6.6	6.8	6.9	7.4	5.6	14.3
New Mexico	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3
Tennessee	4.1	4.5	4.8	5.2	5.5	5.9	6.2	6.6	6.9	7.3	3.9	0.0	14.3
Virginia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3
New York	29.7	26.1	22.8	19.6	16.3	13.0	7.8	6.5	3.2	0.0	0.0	0.0	14.3

Table 4: Cropland Allocation in a Mixed Asset Portfolio without Restriction

	Portfolios																Naïve
E(Rp)	6.5	6.9	7.3	7.7	8.1	8.5	8.9	9.3	9.7	10.1	10.5	10.9	11.6	12.0	12.4	12.8	13.2	9.5
St. Dev.	2.0	2.1	2.1	2.1	2.2	2.3	2.4	2.5	2.7	3.2	3.7	4.3	6.2	6.3	7.1	6.0	9.5	3.9
S&P500	1.7	1.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5	2.3	0.0	0.0	4.2
Dow Jones	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
North America	0.0	0.0	0.0	2.2	2.4	2.7	2.9	3.1	3.4	3.3	3.2	3.2	0.0	0.0	0.0	0.0	0.0	4.2
All REITs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
BBALibor	41.4	33.2	25.0	20.4	13.1	6.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
T-10y	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Baa	36.0	43.7	51.5	58.1	64.2	70.1	75.3	75.6	69.4	60.0	50.3	40.6	16.9	14.4	4.9	12.9	0.0	4.2
Aaa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
CRBSpot	5.8	5.3	4.7	4.6	4.3	4.0	3.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Colorado	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	83.5	0.0	4.2
Montana	0.0	0.0	0.0	0.0	1.2	2.4	2.5	2.9	4.9	8.2	11.7	15.1	38.9	24.3	27.7	3.6	100.0	4.2
New Mexico	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Illinios	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Indiana	0.0	0.0	0.0	10.4	10.6	10.9	8.7	5.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Iowa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Missouri	0.0	0.0	0.0	0.0	0.0	0.0	4.2	11.6	21.4	28.5	34.8	41.2	0.0	58.8	65.1	0.0	0.0	4.2
Florida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Tennessee	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Virginia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
New York	5.6	6.4	7.1	4.3	4.2	4.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Louisiana	9.5	9.6	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Mississippi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.8	0.0	0.0	0.0	0.0	4.2

DISCUSSION

The purpose of this study was to replicate and expound upon the findings of Hennings et al. (2005). As such, it is important to identify where the two studies' findings are similar and where they differ.

Overall, average returns are similar in both studies, despite the decade of new data added. Standard deviations did not see a significant difference between the two studies. When considering asset classes for inclusion in the data, Hennings et al. (2005) included Hybrid REITs and SLBond, which were not tested in the current study. In both studies, BBA Libor and Baa bond interest rate portfolios dominated the lower-risk returns. The most conspicuous difference between studies is that at mid- to higher-risk levels, equity REITs began to dominate Hennings' et al. (2005) portfolio, culminating at 100% at the highest risk-return level. This is opposed to the current study, where at no risk level were weights given to equity REITs. it's possible that the exclusion of the two variables discussed earlier, Hybrid REITs and SLBonds, could have played into the reasoning for why weights are not given. Exclusion and inclusion of variables can cause weights to shift at different risk return rates.

Of the farmland states considered, Hennings et al. (2005) included Nevada. This was not possible in the current study, as Nevada data were not unavailable. Instead, because of its geographic proximity and similar climate, New Mexico was included. In Hennings et al. (2005), weights are given to Nevada returns up into the mid-high level of risk. In the current study, New Mexico weights were never included in a portfolio. This could indicate that regional similarities do not necessarily mean that there will be equally effective farmland available. Hennings et al. (2005) found that at the highest level of return, portfolios were 100% invested in Colorado farmland. In the current study, at the highest level of return, portfolios were 100% invested in Montana farmland. Beyond these contradictions, results are similar across farmland states.

When comparing both farmland and equity investments together, similar data output was found in weights from equities, which took a larger percentage of the portfolio in lower returns, and farmland taking larger percentages as returns increase. When considering weights greater than 10.0% we find 38 observances across returns in Table 4. Of the 38 observances, when returns were less than 9.3%, 20 were traditional assets and 18 were farmland assets. 60% of traditional assets are found in the portfolio before the 9.3% return and 40% reside within returns greater than or equal to 9.3%. 16% of farmland assets were found in portfolios with returns less than 9.3%. 84% of farmland assets are included at returns equal to or exceeding 9.3%.

One limitation to the current study is that it does not take into consideration the financial crisis of 2009 and its effect on investments, whether equity or farmland. It is possible that this event is yet another reason why data in the current study differ slightly from Hennings et al. (2005). However, despite the financial crisis agriculture investments continue to be a stronghold for investments, a claim supported by Hennings et al. (2005) prior to 2009. Future research could benefit from testing on a structural break for the 2009 financial crisis. A CHOW test could be utilized to test for this structural break.

The ten additional years of data supplied in this study have all been within the 15 hottest years on record (NOAA, 2015). It is possible that climate change has had an impact on agricultural investment because of drought and crop failure. A future study which incorporates precipitation, temperature, natural disasters, and geographic changes (e.g. due to natural disasters) could show that climate change has the propensity to affect investments.

CONCLUSION

Research on agricultural investments have shown that its value within a portfolio can have resounding impact on the level of return. The current study sought to expand on the research of Hennings et al. (2005) by replicating methodology but with the addition of ten years of new data, thus expanding the reference period from 1969 to 2015. The intent of Hennings et al. (2005) and of the current study was to present evidence that by including farmland assets in a portfolio, investors can still achieve a higher rate of return at a lower level of risk.

The information in the current study is comprised of returns for various asset classes and different individual returns series inside every asset class. After transforming all data into annual figures, traditional assets NASDAQ, Equity REIT's, and All REIT's demonstrate the most noteworthy mean returns. The farmland states with the highest average returns was Colorado, Montana, Illinois, Indiana, Iowa, Missouri, Tennessee, New York, and Mississippi. There was, however, no geographic localization in the outcome—four distinct geographic regions were included. As analysis shifted to focus on the impact of land investment on blended asset portfolios utilizing cropland returns, it was apparent that the reduction of risk is possible. Cropland presented a low or negative relationship with different assets.

Both studies share expansive data from which to draw conclusions. While dissimilar investment combinations may draw some differences, consistency is apparent across studies. Indeed, in both studies at higher levels of return, farmland begins to take over the portfolio, suggesting that it is a low-risk, high-reward investment.

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APPENDIX A: TABLES

Tables 1, 3, 4, and 6 below are tables from Hennings et al. (2005) that were used for comparison in the replication.

Table 1: Basic Statistics for Different Assets Types

Variable	Observations	Mean	Std. Dev.	Min	Max
SP500[1]	44	0.06808	0.15743	-0.3527	0.2935
DOWJONES[1]	44	0.06213	0.15469	-0.3227	0.32448
NASDAQ	19	0.11016	0.28727	-0.499	0.61834
NYSE[2]	37	0.07275	0.15833	-0.3607	0.31063
EAFE[2]	34	0.0755	0.23221	-0.6054	0.53027
EUROPE[2]	34	0.07232	0.18855	-0.3127	0.54992
PACIFIC[2]	34	0.08248	0.2778	-0.4301	0.70467
NORTH AMERICA[2]	34	0.10713	0.16513	-0.3095	0.31534
ALLREITS[3]	32	0.09627	0.20474	-0.5487	0.3986
EQUITY REITS[3]	32	0.12143	0.15663	-0.2408	0.38926
MORTGAGE REITS[3]	32	0.07228	0.29047	-0.6038	0.57292
HYBRID REITS[3]	32	0.08274	0.27983	-0.7386	0.44592
BBALIBOR	18	0.05655	0.02011	0.01271	0.09294
ED3M[4]	33	0.07312	0.03455	0.01142	0.16995
TBCM1Y	44	0.06311	0.02818	0.01244	0.14778
TBSM3[4]	44	0.05714	0.02651	0.01011	0.14025
T10Y[4]	44	0.07133	0.0252	0.03879	0.13911
SLBOND[4]	44	0.06111	0.02051	0.03162	0.11659
CD3M[4]	39	0.06827	0.03021	0.01151	0.16122
BAA[4]	44	0.08943	0.02819	0.0483	0.16113
AAA[4]	44	0.07947	0.02476	0.04258	0.14171
CP3M	33	0.06867	0.03083	0.0111	0.1534
REUTERS[5]	43	0.02668	0.15086	-0.1719	0.602
CRBFI[5]	44	0.02126	0.11672	-0.1909	0.38939
CRBSPO[5]	44	0.02375	0.11179	-0.1446	0.44811
CPI[1]	44	0.04195	0.029	0.00669	0.12482
PPI[1]	44	0.03382	0.04711	-0.0613	0.18968

[1] Source: Financial Forecast Center (www.forecasts.org)
[2] Source: Morgan Stanley Capital International Inc web site (www.msci.com)
[3] Source: National Association of Real Estate Investment Trusts
[4] Source: H.15 release of the Federal Reserve
[5] Commodity Research Bureau data base

Table 3: Efficient Portfolio – Traditional Assets

	Portfolios																	Naïve
E(Rp)	5.6*	5.9*	6.3*	6.6*	7.0*	7.3*	7.7*	8.3*	8.7*	9.0*	9.7*	10.1	10.4	11.1	11.4	11.8	12.1	6.7
St. Dev.	1.3	1.3	1.4	1.5	1.6	1.8	1.9	2.3	2.5	2.8	4.4	5.8	7.2	10.3	11.8	13.4	15.4	6.3
NASDAQ	1.2	1.4	1.5	1.6	1.6	1.5	1.4	1.4	1.5	1.6	4.0	5.3	6.5	9.1	10.4	11.7	0.0	9.1
Equity REITS	0.0	0.0	0.0	0.0	0.0	1.1	2.2	2.9	2.8	3.0	21.8	31.8	41.7	61.6	71.6	81.5	100.0	9.1
Mortgage REITs	2.9	2.9	2.8	2.5	2.2	1.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
HybridREITs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
BBALibor	66.7	67.6	65.6	56.9	48.3	40.8	33.4	16.5	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
SLBond	21.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
CD3M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
Baa	0.0	11.1	22.5	32.3	42.0	50.2	58.2	76.4	86.1	94.9	74.2	63.0	51.7	29.3	18.0	6.8	0.0	9.1
Reuters	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
CRB Fut	1.9	1.3	1.1	0.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
CRBSpot	6.2	6.5	6.4	6.0	5.5	5.1	4.3	2.7	2.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1

* Statistically significant improvement in portfolio efficiency over the naïve portfolio (95% confidence level)

Table 4: Efficient Portfolio when Assets Classes are Restricted to Cropland – 50% Upper Quintile of Production Values

	Portfolios																	Naïve
E(Rp)	11.2	11.4	11.6	11.8	12.0	12.2	12.4	12.6	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.4	11.2
St. Dev.	4.9	5.0	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.8	6.0	6.2	6.5	6.8	7.1	7.6	8.6	5.1
California	10.1	7.8	5.5	3.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3
Colorado	18.7	20.3	22.0	23.7	25.3	27.2	29.3	31.4	33.0	34.2	36.1	40.7	45.4	50.0	54.6	67.6	100.0	14.3
Montana	15.0	15.8	16.5	17.2	18.0	18.6	19.1	19.6	20.9	23.2	25.9	29.3	32.8	36.2	39.7	32.4	0.0	14.3
Nevada	4.6	4.9	5.3	5.6	5.9	5.7	4.9	4.1	2.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3
Tennessee	7.7	10.7	13.4	16.3	19.3	22.5	26.0	29.5	33.2	37.0	38.0	29.9	21.9	13.8	5.7	0.0	0.0	14.3
Virginia	17.4	17.0	17.0	16.8	16.5	15.7	14.4	13.2	9.9	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3
New York	26.5	23.5	20.3	17.2	14.2	10.4	6.3	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3

Table 6: Cropland Allocation in a Mixed Asset Portfolio without Restrictions

	Portfolios																				Naïve
E(rp)	6.5	6.9	7.3	7.7	8.1	8.5	8.9	9.3	9.7	10.1	10.5	10.9	11.6	12.0	12.4	12.8	13.2	13.6	14.0	14.4	9.5
St. Dev.	1.2	1.2	1.3	1.4	1.5	1.7	1.8	1.9	2.4	2.5	3.0	3.0	3.0	3.8	4.5	4.7	5.3	6.0	7.3	8.6	3.9
S&P500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Dow Jones	1.3	2.1	2.1	2.7	0.0	3.3	0.9	1.0	2.4	0.6	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	4.2
North America	0.0	0.0	0.1	0.0	2.7	3.2	4.6	5.5	5.0	5.8	4.5	9.9	7.5	1.7	15.9	12.3	13.9	13.0	0.0	0.0	4.2
All REITS	0.8	0.5	0.7	0.0	0.4	0.1	0.8	0.1	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	4.2
BBALibor	32.8	22.9	20.8	14.4	12.9	8.7	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
T-10y	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
SLbond	52.6	60.1	58.9	56.7	55.8	52.8	51.7	48.7	43.0	41.6	37.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Baa	0.0	0.0	0.2	3.7	4.0	3.6	6.1	10.4	9.1	8.8	7.9	11.6	43.3	29.4	9.3	12.3	2.0	0.0	0.0	0.0	4.2
Aaa	0.0	0.0	0.1	1.9	1.8	0.5	1.6	3.2	0.3	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	4.2
CRBSpot	5.1	4.4	3.0	2.4	1.2	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	4.2
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	4.2
Colorado	0.0	0.0	3.1	3.8	5.3	7.6	7.9	9.3	13.9	15.0	18.0	17.3	18.5	24.5	28.6	32.3	37.0	45.2	54.3	100.0	4.2
Montana	0.0	0.0	0.2	0.0	0.9	2.9	4.0	5.4	9.1	10.1	12.5	13.6	15.6	20.6	24.1	29.3	33.8	39.5	43.2	0.0	4.2
Nevada	0.3	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	4.2
Illinois	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	4.2
Indiana	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	4.2
Iowa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	4.2
Missouri	2.4	5.4	5.8	5.5	5.8	6.7	6.3	4.4	6.1	6.6	7.7	5.3	0.0	2.3	3.9	0.0	0.0	0.0	0.1	0.0	4.2
Florida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	4.2
Tennessee	0.0	4.1	4.7	7.4	7.8	8.4	9.3	10.2	11.1	11.4	11.9	12.8	15.0	16.7	18.0	13.8	13.4	2.2	0.5	0.0	4.2
Virginia	0.0	0.0	0.0	1.6	1.5	0.8	1.5	1.7	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	4.2
New York	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Louisiana	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Mississippi	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2