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American Society of Farm Managers & Rural Appraisers

# Letter from the Editorial Committee Chair


**DR. GREGORY IBENDAHL**

Associate professor at Kansas State University & Editorial Committee Chair


Dear ASFMRA Members and Friends of Agriculture:

The ASFMRA Editorial Committee is proud to present the Society's 2019 Journal. This year, 17 papers were accepted for publication in the Journal. This collection of papers provided our Committee with a wide assortment of topics to review and evaluate for your reading pleasure.

You will find topics on most of the appraisal, management, and agricultural consulting issues that we frequently see and/or experience in our respective professions. These papers include research and case studies illustrating new, reformed and/or revised ideas and techniques.

Examples of the many topics included in the *2019 Journal of ASFMRA* are:

- Farm liquidity
- Profitability of different enterprises
- Financial benchmarking
- Financial stress
- Risk management

The 2019 Journal contains the most up-to-date collection of rural appraisal, agricultural consulting, and farm management topics available in the world. In the following pages you will find cutting-edge manuscripts documenting research, field studies, practices and methodologies proposed by the leading academic, appraisal, consulting, and management leaders of agriculture. This edition of the Journal continues to provide our membership and the agri-business community with topics on newly evolved issues and concepts for your review and consideration.

The Editorial Committee worked with the authors to ensure that each article was informative, clear and precise in the presentation of data and conclusions, and consistent with ASFMRA goals. We particularly worked to find articles that were more applied and less theoretical.

The Editorial Committee continues its challenge to all readers to join our highly acclaimed group of published authors. Share some of your experiences and wisdom! Most of us have encountered at least one unusual problem or situation that required original and innovative thinking to develop workable solutions. If it was new for you, chances are it will be interesting and usable by others.

The Editorial Committee thanks you for your continued interest in the ASFMRA, agriculture, and the entire agricultural community.

Dr. Gregory Ibendahl

*Associate professor at Kansas State University and Editorial Committee Chair*

# Thank you to the 2018–19 Editorial Committee


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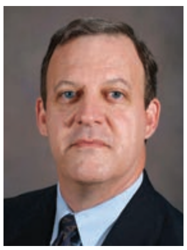
# Agricultural Labor Trends: Considerations for Farm Operators and Managers



**By Maria Bampasidou and Michael E. Salassi**

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## Abstract

*Labor shortages have been widely reported in the agricultural sector. This paper documents recent trends in the United States farm labor market, and trends in nonimmigrant seasonal hired labor as reported through the H-2A guest worker program. The challenges that farm operators and farm managers may encounter because of a changing agricultural workforce and when employing guest workers are discussed. Topics include labor market parameters (adverse wage effect rate), labor policy changes (minimum wage), and transaction costs relevant to the H-2A program application process (application time and determination time, provisions to guest workers).*

## INTRODUCTION

Labor shortages in agriculture in the United States have been documented extensively over the past few years. These labor shortages mostly have been tied to specific agricultural industries and particular areas of the country. Examples include the apple industry in Washington (Turnbull, 2011), the fruit and vegetable industry in Georgia (McKissick & Kane, 2011), the strawberry industry in Florida (Guan et al., 2015; Wu & Guan, 2016) and the strawberry industry in California (Hill, 2018). The production cycles and production conditions in agriculture dictate the periods when labor demand is at its peak, hence making labor shortages more prominent. This is particularly important in industries where the product is perishable (Wu & Guan, 2016) or in the presence of adverse weather events that can be catastrophic for the crop and, in turn, for the financial viability of the agricultural operation.

The introduction of technology in production practices and technological innovations assisted agricultural industries, for example row crops, to substitute away from labor into capital by investing in tractors, combines, harvesters, etc. The need for manual field labor in these industries was replaced by the need for agricultural equipment operator labor, requiring a different set of skills. Nevertheless, complete substitutability of capital for labor is unlikely in agriculture. Many agricultural production sectors, such as the vegetables, berries, livestock, and crawfish to name a few, are heavily dependent on labor and are not significantly mechanized. Unavailability of labor can lead to delayed harvesting, which can adversely affect crop product quality and resulting farm business revenue (Wu & Guan, 2016). In addition, labor shortages can affect regional crop production sectors by shortening their marketing window (e.g., tomato production in Florida and tomato production in California) as well as competition with industries outside the United States (e.g., tomato production in Mexico).1

Agricultural tasks, though they may not require extensive training, are labor-intensive and can be skill-dependent (Martin, 2016). In addition, many farm and ranch tasks are conducted under difficult or extreme working conditions. Moreover, because of the production cycles in agriculture, the majority of these farm labor positions are short-term, seasonal or temporary. These parameters could deter skilled and unskilled domestic workers to apply to fill these positions, as those individuals may look for other long-term employment opportunities. In the period 2003–2017, there has been a downward trend in the number of farm workers in the United States, with an average decline of 5,200 workers per year over the period. Over the past 10 years, this farm labor decline has slowed somewhat, but still exhibited an annual average decrease of approximately 2,000 farm workers per year (USDA, NASS 2003–2017).

To counter labor supply shocks, farm operators and managers have the choice to offer higher wages to attract domestic workers and/or to consider employing seasonal foreign workers (Ifft & Jodlowski, 2016; Wu & Guan, 2016). Both these actions result in increased costs to the farm business. Higher salaries are reflected directly in financial statements and enterprise budgets as increased labor costs. Employing foreign workers means additional costs related to searching for a willing and able labor force (e.g., advertising, listing agents, immigration lawyers), adapting hiring practices (e.g., contract-based employment, offering prevailing wage rates), and potentially different labor management practices (e.g., employee selection, maintain an audit trail). Agricultural farm business enterprises usually operate on slim profit margins, which make these transitions hard decisions to make. In addition, depending on the scale of the farm business operation, the time required to make such a transition in farm labor acquisition can lead to a temporary reduction in operational efficiency, until the requirements and practices of acquiring foreign labor becomes more familiar and routine to the farm operator or manager.

Moreover, when farm operators and managers decide to hire foreign workers, they also need to take into consideration changes in immigration policies. The stricter enforcement of United States immigration laws (Ifft & Jodlowski, 2016; Wu & Wang, 2016; Devadoss & Luckstead, 2017; Martin, 2017; Charlton & Konstandini, 2018) and an increase in anti-immigrant sentiment (Ifft & Jodlowski, 2016) were related to the reduction of immigrants coming to the United States to fill seasonal agricultural labor positions, hence restricting the available farm labor pool. Farm operators and managers turn to guest worker programs to meet their need for seasonal and temporary labor. The H-2A program is commonly used by farm and ranch operators in the United States to hire agricultural workers on a seasonal basis. This program has been in operation since 1986. However, several factors have deterred many farm operators and managers from using the program extensively, including the completed and time-sensitive worker application process, changes that have occurred over time in the program provisions, costs associated with the livelihood of the workers, and incomplete information regarding the program and United States government regulations (Guan, Wu, & Whidden, 2013; Guan et al., 2015; Martin, 2016; Escalante & Luo, 2017).

In this paper, we comment on current trends in the United States farm workforce. In particular, we report trends in the United States farm labor and trends in the H-2A program utilization. We discuss the adverse effect wage rate and comment on the implementation of a higher minimum wage; two wage rates that are frequently used in determining agricultural labor costs. Focusing on the H-2A guest worker program, we address challenges regarding filling application time and transaction costs relevant to the program. Hence, we stress the importance of revisiting labor management practices as farm operators and managers prepare to cope with continued labor shortages and policies that could affect future farm labor supply.

## TRENDS IN U.S. FARM LABOR

Over the past 10 years, farm worker numbers in the United States, although varying from one year to the next, have remained relatively stable between 700,000 and 760,000 workers (Figure 1). A significant decline in the agricultural labor force occurred in the prior period, when total United States farm worker numbers decreased from 885,700 in 2002 to 731,500 in 2008. Farm wages have adjusted to this declining workforce. Real average farm wages in the United States, adjusted for inflation, remained relatively constant between 2003 and 2011, averaging $12.11 per hour (Figure 1). However, after 2011 real farm wages increased, reacting in part to the decline in farmworker numbers. The real average farm wage, adjusted for inflation, was $12.05 per hour in 2011 and has increased steadily since, reaching $13.32 per hour in 2017.

Changes in farmworker numbers and farm wages across states and regions exhibited similar trends to what has been observed nationally, although some differences exist across the regions. Many of the states or regions have observed decreasing trends in farm labor and increasing trends in real farm wages. California, the largest employer of agricultural labor in the United States, has seen the largest decline in farmworker numbers, dropping 32 percent from 2003 to 2017 (Table 1). Florida, another major employer of agricultural workers, also has seen its farm workforce decline by 32 percent. Some areas however, the Appalachian and Mountain regions for example, have seen slight increases in farmworker numbers. Across the entire United States, farmworker numbers have declined by an average of 5,200 workers per year between 2003 and 2017. Over the past 10 years, the farm workforce has declined by an average of 1,950 workers per year.

Although all but one region of the country has seen increasing trends in average real farm wages, the magnitude and level of these wages vary from region to region (Table 2). Over the 2011 to 2017 period, the Pacific States and California had the largest increases in farm wages, with average annual trend increases of $0.30 and $0.42 per hour per year, well above the national average trend increase of $0.22 per hour per year. Regions with the highest farm wage level in 2017 were the Northern Plains, Pacific States, and California, with real average farm wages of $14.18, $14.64, and $14.46 per hour, respectively. Regions with the lowest average farm wages in 2017 included the Southeast, the Delta States, and the Mountain regions, all with average farm wages below $12.00 per hour.

## TRENDS IN H-2A PROGRAM UTILIZATION

Guest worker programs were launched in the United States in 1943. The sugarcane industry was the first to employ seasonal agricultural workers from the Caribbean (DOL n.d). The program in its current form was introduced under the Immigration Reform Act of 1986. Since then, the program has expanded its focus and now caters to the majority of the agricultural industries in the country and employs people from 83 countries (DOL, n.d.).

Under the H-2A program, farm operators and managers can employ nonimmigrant labor (other terms used include seasonal and temporary labor, and guest worker labor) for agricultural activities where a shortage of domestic labor is anticipated. The program emphasizes the seasonal and temporary nature of the positions to be filled under the program. Each application is evaluated by the United States Department of Labor (DOL) Employment and Training Administration (ETA) and needs to document the unavailability and insufficiency of local domestic workers to perform the agricultural activities pertaining to the respective operation. In addition, the application must also document that the employment of workers under the H-2A program will not negatively affect the wages and working conditions of local domestic workers capable and willing to be employed for the agricultural tasks mentioned in the application (DOL, n.d.).

Over the past 10 years, we observed a more profound turn to the H-2A program as reported by the Office of Foreign Labor Certification (OFLC). Table 3 presents information on the number of applications examined (i.e., determined), the number of certified applications, the number of positions requested, and the number of positions certified for the period FY2008–FY2018 (Q3). Annual administrative data from employers' H-2A applications (reported in ETA Form 1942) for the period FY2008–FY2017 showed an increase in the number of determinations and the number of certified applications. The difference in the numbers depicts denied and/or withdrawn applications. On average, the OFLC examined 8,683 applications each year. The lowest number of applications were submitted in 2011 (7,361), and the highest number of applications were submitted in 2015 (10,339). The biggest drop in the number of determinations was observed from 2015–2016, and the highest increase in 2016–2017. Data on FY2018 show that the OFLC has examined more than the average annual number of applications by the third quarter of the year.

The demand for H-2A labor has increased significantly over the period 2008–2017. Since 2011, we observed a continuous increase in the number of people requested through the H-2A program. Farms and ranches in the United States requested 83,844 positions in 2011 (the lowest number in the period 2008–2017), and the highest number of positions requested was in 2017 (206,156 positions requested); a 146 percent increase from 2011. Similarly, the number of certified positions has had an upward trend. Between the period FY2011 and FY2017, we observed an increase in the number of certified positions by 159 percent. Also notable is that the numbers for FY2018 as reported up to quarter 3 have surpassed the numbers for 2016, and are close to the 2017 numbers.

Table 4 presents information by farm region in the United States for the period 2009–20162. As documented by the number of certified positions, we observed the highest concentration in the Northeast I, Appalachian I, Appalachian II, Southeast, Delta States regions, and Florida. These areas employed approximately 50 percent of the H-2A guest workers each year. For the majority of the regions (14 out of 17), we observed a decline in the number of certified positions during the period FY2009–FY2010; for 11 of them, it was the lowest year-to-year decrease in the number of certified positions for the period 2009–2016. This can be explained by the 2009 recession, which may have led domestic workers to turn to the available seasonal employment. In addition, in the period 2009–2010, we observed a 6.1 percent decrease in the number of petitions examined (Table 3), which showed a decrease in the demand for the H-2A program.

## CONSIDERATIONS FOR FARM OPERATORS AND MANAGERS

### Wage Rates—Adverse Effect Wage Rate and Minimum Wage

Regarding the wage regulations pertaining to the H-2A program, guest workers are paid based on the highest rate of (i) the adverse effect wage rate (AEWR), (ii) the minimum wage at the federal or state level, (iii) the prevailing wage, (iv) the prevailing piece rate or (v) the agreed-upon collective bargaining wage (DOL-ETA, 2018). The AEWR is defined by region, taking into consideration the annual weighted average hourly wage rate for field and livestock workers combined. The AEWR is meant to be a wage rate measure that does not affect the compensation of domestic workers negatively.

The AEWR, though it provides a good measure to capture the compensation of the H-2A workers, is also a wage metric that may not be the best representative of the compensation schedule. The AEWR is based on aggregate information on wage rates by region. These regions are defined geographically by the DOL and can incorporate more than one state. It can be argued that the composition of the regions captures the concentration of the industries in that region, but that may not be true regarding the representation of the socioeconomic characteristics of these regions. For example, the Delta States region includes Arkansas, Louisiana, and Mississippi. These are agriculture-dependent economies and share similar production systems (e.g., rice, broilers, soybeans, cattle), but they also have unique production systems (e.g., Louisiana-crawfish, alligator, and sugarcane). In addition, these states have different economic indicators; for example, GDP measured in 2018 (Q1)—Arkansas $127.06 billion; Louisiana $254.06 billion; Mississippi $114.33 billion 3 (BEA, 2018). Taking into consideration that agricultural industries operate in rural areas, the wage rate also needs to account for living standards at the local level, which may not be representative of the state and the specific region for which the AEWR is determined.

Farm and ranch operators and managers deal with contractual agreements and, particularly in the case of hiring H-2A workers, these contractual agreements, i.e., the ETA form 790, need to be approved prior to filing a petition with the United States Citizenship and Immigration Services (USCIS). As discussed above, the minimum wage will be offered if it is the highest wage of the five rates approved by the United States Department of Labor (DOL). One debate topic is the minimum wage versus a living wage. As of 2018, 29 states offer a higher minimum wage than the federal wage and consider further increasing the minimum wage rate. In 2018, 18 states raised their minimum wage rate to more closely match living costs or because of previously enacted legislation (NCSL 2018). 4 As stated before, agricultural farm business operations operate with thin profit margins, and particularly in labor-intensive enterprises. Potential increases in the minimum wage rate can affect the demand for domestic labor and the demand and affordability of the H-2A program. Once again, labor costs need to be scrutinized, and it becomes even more important for farm operators and farm managers to have a good understanding of how AEWR and minimum wages could affect the financial viability of their operation.

### H-2A Program Application—Incomplete Information or Regulatory Hurdles?

The H-2A program has been characterized as cumbersome and not easy to navigate, apart from being a costly alternative (Guan, Wu, & Whidden, 2013; Martin, 2016).5 Hence, many farm operators and managers, though they are aware of the program, opt not to apply. Even in the case where farm operators and managers apply to the program, we observe a significant difference in the number of petitions and certified applications and in the number of positions requested and positions certified (Table 3).6 Several reasons for this difference include the arguments regarding the complexity of the program requirements, including a timely petition of employees; a period of stay requested; proof of seasonal nature of the job; proper worker provisions such as housing, transportation, and health; and job offers to natives while employing H-2A workers.

An employer must submit an application no later than 45 days before the employer's first date of need. The H-2A program does not have a cap (the H-2B program is capped at 66,000 people entering with a guest worker visa), which can add another restriction when applying to the program. Nevertheless, the application needs to match the farm or ranch production activities specified and highlight the seasonal and temporary nature of these activities. This will also determine the period of stay for the H-2A workers, which has a maximum term of 10 months.

Another important aspect of the program is the housing, transportation, daily subsistence, compensation, and health provisions provided to H-2A workers. The first three items do not pertain when you hire domestic workers, but for farm operators and managers employing through the guest worker program, these provisions need to comply with applicable local, state or Federal standards as described in 20 CFR 655.122(d)(ii) (DOL, n.d.). Transportation fees arise in the form of transportation costs to file and obtain a visa to enter the United States as well as transportation between the worksite and lodging establishment. For the respective items, farm operators and managers also need to consider costs related to daily subsistence.

The contractual agreement when hiring H-2A workers also needs to satisfy that domestic workers who apply for a job in the same period with H-2A workers are to also be considered for employment. This applies for the first half of the employment period for which H-2A workers are contracted. During the first 50 percent of the contract period, employers need to hire eligible and able domestic workers regardless of the number of domestic and H-2A workers already working for them (DOL, n.d.). This creates potential complications when the farm business employs at maximum capacity and the costs of hiring additional workers are substantial.

There are also complications on the administration of the H-2A program itself. Producers' comments include the complexity regarding the application process, the amount of paperwork required, and the time it takes for a decision to be made (e.g., Guan, Wu, & Whidden, 2013). Many applicants decide to use a consulting agent or legal firm to help them with the process. Data for the third quarter of 2018 report that about 70 percent of the applications were filed through such a supporting firm.7 This adds to the cost to the farm business of applying to the program. Regarding the time of a decision, the average decision period reported was 29 days, a minimum of two days, and a maximum of 314 days8; in both cases, the applications were withdrawn from consideration, and the operators did not employ a legal firm.

## DISCUSSION

In this study, we documented the changing profile of the agricultural labor market and presented trends regarding farm labor and H-2A nonimmigrant labor in the United States. If these trends persist, farm managers, farm operators, and farm advisors would need to position themselves and their clientele to better address labor shortages and increasing demand for seasonal foreign hired labor. Several important parameters regarding valuation of labor costs are discussed relevant to the AEWR, and the minimum wage rate. These two measures are used in determining agricultural labor costs and are of particular importance should the usage of H-2A workers continues to increase. Incomplete and asymmetric information regarding the H-2A program, as well as misconceptions or misinterpretations of the program and the contractor's responsibilities, could increase the hesitation of some farm business operations to utilize the program.

The parameters considered in this study are not an exhaustive list of considerations important to farm decision makers dealing with labor shortages and considering turning to the H-2A program to address labor demand. Still, more examination is needed to determine what deters farm operators and managers from applying to the program. Regulations pertaining to the program can be difficult to understand and to apply, so we expect more applicants to turn to an agent or legal firm to assist them with the process. The changing policy environment (e.g., H-2C program) could also generate additional topics of concern. The farm labor market in the United States is more complicated than it is perceived. Farm and ranch operators and managers not only need to secure sufficient farm labor, but they also need to equip themselves with farm labor management practices that can accommodate the changing profile of the available farm and ranch labor force.

## FOOTNOTES

1. Guan et al. (2015) report on the competitiveness of the Florida strawberry industry versus that of Mexico.
2. Table 4 compiles information from OFLC reports for the period 2009–2016. These reports were retrieved August 5, 2018, and the numbers provided are based on authors' calculations.
3. Numbers reported as millions of dollars in current dollars seasonally adjusted at annual rates.
4. Alaska, Florida, Minnesota, Missouri, Montana, New Jersey, Ohio, and South Dakota increased their rates based on cost of living. Arizona, California, Colorado, Hawaii, Maine, Michigan, New York, Rhode Island, Vermont and Washington based increases on legislation and ballot decisions. Source: National Conference of State Legislatures. http://www.ncsl.org/research/labor-and-employment/state-minimum-wage-chart.aspx.
5. Reports include the Migration Policy Institute (Chishti & Bolter, 2017); United Press International (Ong, 2015); The Labor Brain (The Labor Brain, n.d.)
6. Here we should note that some of the petitions are withdrawn prior to being determined as eligible. These numbers can explain some of the differences in the number of petitions and the number of certified applications.
7. Author's calculations using DOL-ETA disclosure data for 2018 (Q3).
8. Author's calculations using DOL-ETA disclosure data for 2018 (Q3).

## REFERENCES

BEA 2018. "Gross Domestic Product by State: First Quarter 2018." https://www.bea.gov/newsreleases/regional/gdp_state/2018/pdf/qgdpstate0718.pdf. Accessed August 2, 2018.

Charlton, Diane, and Genti Konstandini. 2018. "How Agricultural Producers Adjust to a Shrinking Farm Labor Supply." Selected paper for presentation at the 2018 Agricultural and Applied Economics Association Meetings. August 5–7, 2018, Washington D.C.

Chishti, Muzaffar, and Jessica Bolter. 2017. “Despite Political Resistance, Use of Temporary Worker Visas Rises as U.S. Labor Market Tightens.” *Migration Policy Institute*. https://www.migrationpolicy.org/article/despite-political-resistance-use-temporary-worker-visas-rises-us-labor-market-tightens.

Devadoss, Stephen, and Jeff Luckstead. 2018. “Immigration Policy and Farm Labor” (working paper).

DOL. n.d. “H-2A Temporary Agricultural Program.” https://www.foreignlaborcert.doleta.gov/h-2a.cfm#. Accessed August 1, 2018.

DOL-ETA. 2018. “Adverse Effect Wage Rates–Year 2018.” https://www.foreignlaborcert.doleta.gov/adverse.cfm. Accessed August 2, 2018.

Escalante, Cesar L., and Tianyuan Luo. 2017. “Sustaining a Healthy Farm Labor Force: Issues for Policy Consideration.” *Choices* 32, no. 1:1–9

Guan, Zhengfei, Feng Wu, Fritz Roka, and Alicia Whidden. 2015. “Agricultural Labor and Immigration Reform.” *Choices* 30, no.4:1–9. https://ageconsearch.umn.edu/bitstream/225845/2/cmsarticle_459.pdf.

Guan, Zhengfei, Feng Wu, and Alicia Whidden. 2013. “Survey of Florida Strawberry Growers.” Unpublished data.

Hill, Alexandra E. 2018. “The Minimum Wage and Worker Productivity: A Case Study of California Strawberry Pickers.” Selected paper for presentation at the 2018 Agricultural and Applied Economics Association Meetings. August 5–7, 2018, Washnigton D.C.

Ifft, Jennifer, and Margaret Jodlowski. 2016. “Is ICE Freezing U.S. Agriculture? Impacts of Local Immigration Enforcement on U.S. Farm Profitability and Structure.” Selected paper prepared for presentation at the 2016 Agricultural and Applied Economics Association Meetings. July 31–August 2, 2016. Boston, Massachusetts.

Martin, Philip. 2016. “Immigation and Farm Labor: Challenges and Opportunities.” AgBioForum 18, no. 3:252–258

Martin, Philip. 2012. *Evaluation of the H-2A Alien Labor Certification Process and the U.S. Farm Labor Market*. U.S. Department of Labor, Employment and Training Administration.

McKissick, John, and Sharon Kane. 2011. “An Evaluation of Direct and Indirect Economic Losses Incurred by Georgia Fruit and Vegetable Producers in Spring 2011.” http://caes2.caes.uga.edu/center/caed/pubs/2011/documents/CR-11-01.pdf. NCSL 2018. “State Minimum Wages|2018 Minimum Wage by State.” http://www.ncsl.org/research/labor-and-employment/state-minimum-wage-chart.aspx.

Ong, Yunita. 2015. “The H-2A Problem: Why a Perfectly Legal Farmworker Visa Program Isn’t Being Used More.” *United Press International*. March 5, 2015. https://www.upi.com/Top_News/US/2015/03/05/The-H-2A-problem-Why-a-perfectly-legal-farm-worker-visa-program-isnt-being-used-more/7521425481876/.

The Labor Brain, n.d. “H2A Program Compliance.” http://laborbrain.com/h2a/.

Turnbull, L. 2011. “Washington Apple Growers Scrambling to Find Workers.” Seattle Times. http://seattletimes.nwsource.com/html/localnews/2016652587_farmlabor31m.html.

USDA, n.d. “Farm Labor.” National Agricultural Statistics Services. Washington D.C. Various issues.

Wu, Feng, and Zhengfei Guan. 2016. “Foreign Guest Workers or Domestic Workers? Farm Labor Decisions and Implications.” Selected paper for presentation at the 2016 Agricultural and Applied Economics Association Meetings. July 31–August 2, 2016. Boston, Massachusetts.

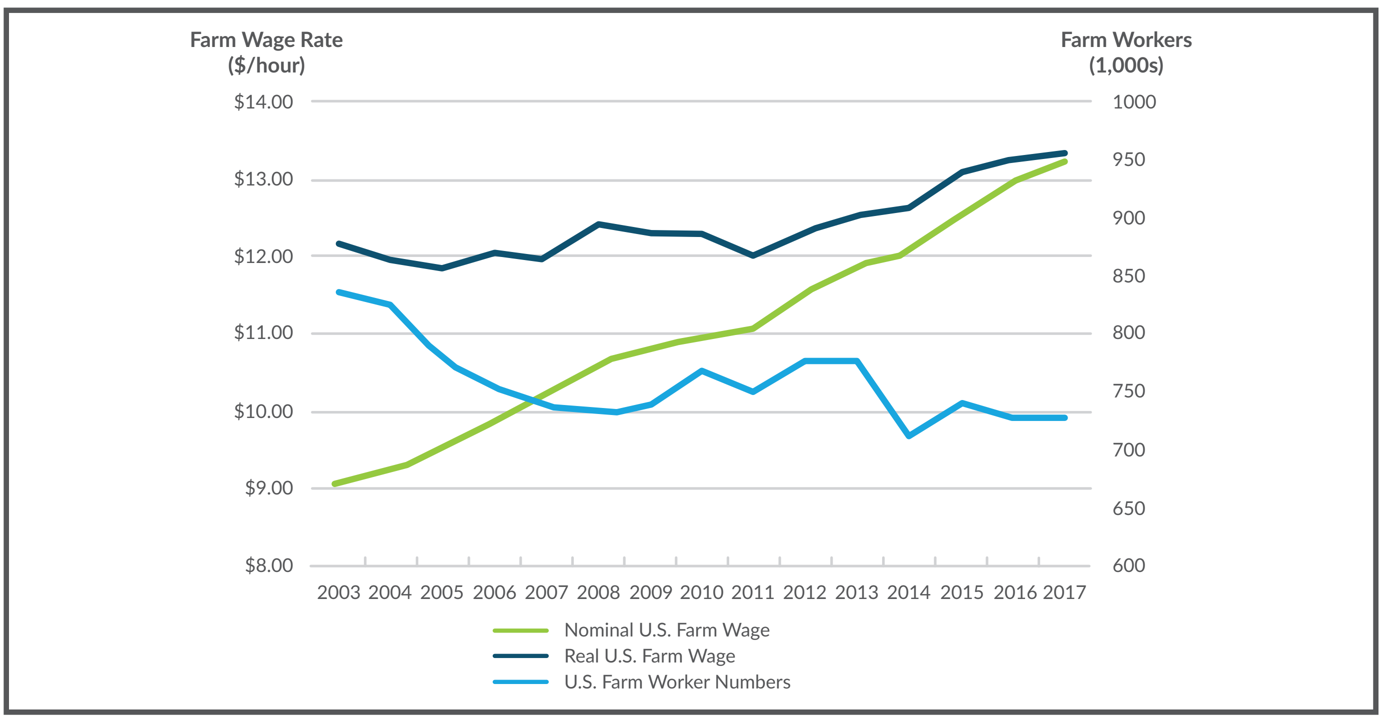


Figure 1 – U.S. Farm Wages and Farm Worker Numbers, 2003 – 2017

**Table 1 – U.S. Farm Worker Numbers by Region, 2003–2017**

| Hired Farm Workers (1,000s) | 2003 | 2008 | 2013 | 2017 | | Trend 2003–17 | Trend 2008–17 |
|---|---|---|---|---|---|---|---|
| Northeast I | 41.0 | 34.5 | 41.8 | 35.3 | | 0.10 | 0.32 |
| Northeast II | 33.0 | 29.8 | 38.3 | 42.0 | | 0.62 | 1.42 |
| Appalachian I | 38.5 | 30.5 | 33.8 | 30.8 | | -0.07 | 0.34 |
| Appalachian II | 33.7 | 25.0 | 24.0 | 25.3 | | -0.54 | 0.06 |
| Southeast | 31.0 | 31.5 | 30.3 | 36.5 | | -0.23 | -0.03 |
| Florida | 54.2 | 45.0 | 44.0 | 36.8 | | -0.97 | -0.90 |
| Lake | 58.7 | 55.5 | 62.0 | 49.8 | | -0.36 | -0.69 |
| Cornbelt I | 42.7 | 38.3 | 40.5 | 39.0 | | -0.39 | -0.38 |
| Cornbelt II | 23.2 | 27.0 | 27.5 | 21.3 | | -0.05 | -0.44 |
| Delta | 26.2 | 28.8 | 24.3 | 29.8 | | 0.00 | -0.28 |
| Northern Plains | 30.7 | 30.3 | 34.0 | 33.8 | | 0.20 | 0.31 |
| Southern Plains | 53.5 | 55.3 | 58.0 | 49.0 | | -0.33 | -0.83 |
| Mountain I | 23.2 | 23.3 | 26.3 | 29.0 | | 0.27 | 0.49 |
| Mountain II | 21.5 | 19.3 | 19.5 | 20.5 | | -0.27 | -0.15 |
| Mountain III | 18.5 | 18.3 | 21.3 | 18.3 | | -0.08 | 0.08 |
| Pacific | 71.5 | 77.5 | 82.3 | 74.8 | | 0.16 | -1.28 |
| California | 227.5 | 156.0 | 163.3 | 153.8 | | -3.16 | 0.00 |
| U.S. | 836.0 | 731.5 | 777.3 | 731.3 | | -5.20 | -1.95 |

Source: *Farm Labor*, NASS, USDA

**Table 2 – U.S Real Farm Wages by Region, 2003–2017**

| Real Farm Wages | 2003 | 2008 | 2013 | 2017 | | Trend 2003–10 | Trend 2011–17 |
|---|---|---|---|---|---|---|---|
| Northeast I | $13.28 | $12.84 | $12.64 | $13.77 | | -0.11 | 0.28 |
| Northeast II | $12.58 | $12.09 | $12.70 | $12.90 | | 0.04 | 0.13 |
| Appalachian I | $11.60 | $11.64 | $11.04 | $12.09 | | -0.03 | 0.22 |
| Appalachian II | $10.70 | $12.07 | $11.54 | $12.00 | | 0.17 | 0.15 |
| Southeast | $11.24 | $10.86 | $11.37 | $11.55 | | -0.05 | 0.11 |
| Florida | $12.22 | $11.78 | $12.25 | $12.61 | | -0.01 | 0.13 |
| Lake | $13.10 | $13.18 | $12.83 | $13.79 | | -0.01 | 0.22 |
| Cornbelt I | $12.85 | $13.00 | $13.09 | $13.65 | | 0.01 | 0.15 |
| Cornbelt II | $13.04 | $13.17 | $13.80 | $13.85 | | 0.01 | 0.18 |
| Delta | $10.39 | $10.99 | $10.72 | $11.15 | | 0.09 | 0.10 |
| Northern Plains | $12.31 | $12.73 | $14.83 | $14.18 | | 0.14 | 0.19 |
| Southern Plains | $11.10 | $11.55 | $12.04 | $12.53 | | 0.06 | 0.18 |
| Mountain I | $10.67 | $11.70 | $11.79 | $12.30 | | 0.15 | 0.21 |
| Mountain II | $12.18 | $12.22 | $12.55 | $11.47 | | 0.02 | -0.11 |
| Mountain III | $10.80 | $12.25 | $11.51 | $11.20 | | 0.20 | 0.07 |
| Pacific | $12.37 | $12.52 | $13.17 | $14.64 | | 0.09 | 0.30 |
| California | $12.37 | $12.92 | $12.51 | $14.46 | | 0.08 | 0.42 |
| U.S. | $12.14 | $12.41 | $12.53 | $13.32 | | 0.05 | 0.22 |

Source: *Farm Labor*, NASS, USDA

| Table 3 – Summary of H-2A Guestworker Program, 2008–2018 (Q3) | | | | |
|---|---|---|---|---|
| **Year** | **Determinations** | **Certified Applications** | **Positions Requested** | **Positions Certified** |
| 2008 | 8,096 | 7,944 | 86,134 | 82,099 |
| 2009 | 7857 | 7665 | 91739 | 86014 |
| 2010 | 7378 | 6988 | 89177 | 79011 |
| 2011 | 7361 | 7000 | 83844 | 77246 |
| 2012 | 8,047 | 7,845 | 90,362 | 85,248 |
| 2013 | 8,388 | 8,118 | 105,735 | 98,821 |
| 2014 | 9,405 | 9,152 | 123,528 | 116,689 |
| 2015 | 10,339 | 9,962 | 145,874 | 139,832 |
| 2016 | 8,684 | 8,297 | 172,654 | 165,741 |
| 2017 | 10,097 | 9,797 | 206,156 | 200,049 |
| 2018 Q3 | 9,856 | 9,565 | 200,363 | 193,603 |

Source: *Annual Report Performance Data*, Office of Foreign Labor Certification, DOL, various issues.

| Table 4 – Number of H-2A Certified Workers by Region, 2009–2016 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **US Farm Region** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** |
| Northeast I (CT,ME, MA, NH, NY, RI, VT) | 7,003 | 5,849 | 6,083 | 5,961 | 7,164 | 6,823 | 7,321 | 7,679 |
| Northeast II (DE, MD, NJ, PA) | 2,227 | 1,748 | 1,636 | 1,770 | 1,851 | 1,963 | 2,471 | 3,104 |
| Appalachian I (NC, VA) | 11,352 | 11,842 | 11,784 | 12,659 | 15,057 | 18,349 | 21,043 | 23,218 |
| Appalachian II (KY, TN, WV) | 8,239 | 7,666 | 6,650 | 7,138 | 8,444 | 9,633 | 9,777 | 10,119 |
| Southeast (AL, GA, SC) | 9,469 | 7,867 | 10,030 | 11,832 | 12,873 | 14,160 | 18,722 | 22,260 |
| Florida | 5,820 | 4,432 | 5,741 | 6,945 | 10,051 | 13,544 | 17,942 | 22,828 |
| Lake States (MI, MN, WI) | 1,620 | 1,134 | 914 | 1,276 | 1,485 | 2,787 | 3,851 | 6,027 |
| Cornbelt I (IL, IN, OH) | 1,821 | 1,569 | 1,422 | 2,012 | 2,559 | 2,671 | 3,102 | 4,541 |
| Cornbelt II (IA, MO) | 1,736 | 1,189 | 1,409 | 1,423 | 1,866 | 1,738 | 2,200 | 3,001 |
| Delta (AR, LA, MS) | 11,672 | 5,436 | 4,894 | 5,540 | 5,769 | 6,091 | 6,543 | 7,394 |
| Northern Plains (KS, NE, ND, SD) | 2,527 | 2,460 | 2,403 | 2,591 | 2,508 | 2,994 | 3,567 | 3,948 |
| Southern Plains (OK, TX) | 3,441 | 2,788 | 2,614 | 2,500 | 2,507 | 2,988 | 3,357 | 3,642 |
| Mountain I (ID, MT, WY) | 3,289 | 3,116 | 2,499 | 2,779 | 2,320 | 2,964 | 3,296 | 3,942 |
| Mountain II (CO, NV, UT) | 5,926 | 5,011 | 4,856 | 4,521 | 3,971 | 4,123 | 4,447 | 5,043 |
| Mountain III (AZ, NM) | 3,959 | 4,857 | 2,584 | 2,601 | 3,102 | 3,923 | 4,007 | 5,772 |
| Pacific (OR, WA) | 2,108 | 3,064 | 3,261 | 4,531 | 6,423 | 9,263 | 12,419 | 14,448 |
| California | 3,503 | 2,629 | 1,598 | 2,862 | 4,199 | 6,043 | 8,591 | 11,106 |
| **TOTAL** | **85,712** | **72,657** | **70,378** | **78,941** | **92,149** | **110,057** | **132,656** | **158,072** |
| **U.S. TOTAL** | **86,001** | **79,014** | **77,290** | **85,248** | **98,302** | **116,689** | **139,832** | **165,741** |
| **% of U.S. TOTAL** | **99.66%** | **91.95%** | **91.06%** | **92.60%** | **93.74%** | **94.32%** | **94.87%** | **95.37%** |

Source: *Annual Report Performance Data,* Office of Foreign Labor Certification, DOL, various issues.

The U.S. Total is the sum of the breakdown by state. We used that to compute the Region numbers. The numbers may differ from the ones reported in Table 3. This could be attributed to an updated count of the certified positions by regions by the time the final report was compiled.

# Costly Foreign Farm Replacement Workers and the Need for H-2A Reforms

**By Cesar L. Escalante, Odeidra Williams, Hofner Rusiana, and Luis Pena-Levano**

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## Abstract

*As undocumented workers have been evicted through immigration control policies and domestic workers have not shown considerable interest in taking on vacated positions, the H-2A Farm Worker Visa Program remains as the legitimate option for hiring replacement foreign farm workers. The program, however, has supplied only about 12 to 18 percent of the U.S. hired labor complement. A recent survey of farmers indicates several patronage issues, such as cost considerations, timing, and processing complexity issues defining the need for changes in H-2A policies and implementation guidelines. Recent legislative reforms were proposed but still await federal authorities' support and final approval.*

## INTRODUCTION

Acknowledgment: This research was funded by a grant from the Southern Sustainable Agriculture Research Education (SARE)

The farm labor sourcing issue has been a recurring theme in many discussions among industry stakeholders, academic researchers, and policymakers in the past several years. Assertions on linkages among immigration control, farm labor supply gaps, and farm business sustainability either have been refuted or supported in many discussion circles. Some views assert that immigration policies have rightfully evicted undocumented workers whose jobs were taken over by unemployed domestic residents, especially during the last economic recession. Others, including certain sectors of the farm industry, present contrasting views.

While some farm businesses have adapted quickly and well to immigration policy-induced changes in the demographic profiles of farm labor supply, many farms, most especially the smaller and relatively more capital-constrained agribusinesses, still struggle to employ productive, reliable, and willing workers who are vital to sustaining business viability of these farms. When labor input substitution and other strategies for coping with an impending farm labor supply gap problem are ineffective, what options are available for these farms?

## FARMERS' HIRING PREDICAMENT

Before dwelling on farm labor sourcing solutions, the farmer's labor hiring predicament is revisited and substantiated to describe the extent of efforts and exhausted alternatives explored by the farmers to sustain their farm business operations. These discussions will only serve to define the emphatic need to promote legitimate labor hiring remedies and ensure their proper, effective, and efficient implementation.

A 2007 study funded by the Southern Sustainable Agriculture and Research Education (SARE) reported two-thirds of surveyed farmers experiencing difficulty in replacing displaced undocumented farm workers with those from the domestic labor pool (Santos and Escalante, 2010). This predicament was corroborated then by news reports (Burke, 2010; Preston, 2007; Seid, 2006; Levine, 2004), individual farmers' testimonials (Martin, 2014; Burke, 2010; Santos & Escalante, 2010), industry officials' statements (Carter, 2011; Rivoli, 2011; Escalante, Perkins, & Santos, 2011), and studies on actual and projected crop losses, unfilled farm labor positions, and economic repercussions (Zahnister et. al, 2012; Mckissick & Kane, 2011). In these accounts, farmers described their frustrations in attracting domestic workers into farm employment even after employing costly advertising and aggressive hiring strategies, including higher wage offers. When some local residents actually showed up to work, their productivity levels were much less compared to the highly efficient work performance of former undocumented employees.

Today farmers continue to deal with the same struggles and frustrations. According to Kristi Boswell of the American Farm Bureau, farmers continue to experience huge crop losses among perishable commodities such as blueberries, apples, and melons (Rosenthal, 2016). Farmers in Georgia lament lost opportunities in their inability to harvest their crops and sell in the market while prices were favorable (Sheinin, 2016). As Idaho farmers have articulated, the potentially available domestic workforce remains unreliable as "... local workers fail to show up, work a few days and quit, or perform work in an unsatisfactory manner" (Cockerham, 2012).

A farmer once summed up his disappointment by labeling domestic workers as "lazy" (Cockerham, 2012). While such allegation may be valid in certain situations, it can aptly be clarified that the farm labor sourcing issue is more than just a nationality or race issue. More appropriately, it is an immigration identity issue and its implications on flexibility or freedom to seek employment in all places. The undocumented workers' lack of employment alternatives because of their immigration status compels them to endure the reality of usually unfairly compensated farm work, with all its harsh demands and exposure to more hazards and risks than other employment options. If these immigrants were granted proper legal identities that give them greater employment flexibility, they would undoubtedly prefer to work in non-farm industries with more attractive compensation packages and safer, more tolerable working environments (Luo & Escalante, 2017).

## LEGITIMATE FOREIGN LABOR HIRING OPTION UNDER H-2A PROGRAM

For a desperate farm business owner, contractual employment, such as through the H-2A Agricultural Guest Worker Visa Program, remains the only legitimate hiring option for the farm sector. The program allows U.S. farmers to temporarily hire nonimmigrant foreign workers to perform full-time temporary or seasonal farm work when domestic workers are unavailable (GAO, 1997). H-2A employment is governed by regulations that are designed to protect the interests of the foreign workers as well as ensure that such employment decisions do not deprive any able, qualified domestic workers of an employment opportunity. To protect the foreign workers from abusive employers, the H-2A program sets wage requirements as well as minimum standards for the provision of housing, transportation, meals, workers' compensation, and other benefits (Mayer, CRS Report to Congress, 2008).

To ensure that hiring foreign workers through the H-2A program will not result in the displacement of domestic workers, visa approvals by the Department of Homeland Security are granted only when the Department of Labor (DOL) certifies that "there are not sufficient U.S. workers who are able, willing, qualified, and available to perform at the place and time needed (Farmworker Justice, 2010).

The visa program has been revisited and amended in recent years. For instance, H-2A employers are now required to list all tasks that the H-2A workers are expected to perform (Souza, 2010) while state workforce agencies inspect worker housing facilities before H-2A hiring commences (DOL). Wage determination policies also have departed from being based on DOL's Occupational Employment Statistics Survey, which was introduced during the Bush administration and reduced farm wages by an average of $1/hour (Souza, 2010; DOL). The amended H-2A program now uses the Adverse Effect Wage Rate Index developed by the Department of Agriculture. The new formula ensures that the wages received by U.S. workers in the same occupation working for the same employer are not below those paid to the H-2A workers. However, experts still contend that the new formula actually results in higher H-2A wages that, as Ron Gaskill of the American Farm Bureau predicts, "could price (the H-2A employers) out of the program (Stallman, 2010)."

The growth rates calculated in Figure 1 present a comparison of two data sources: those based on certifications or approvals made by the DOL and those obtained from the Bureau of Consular Affairs, U.S. Department of State. Differences in total approvals indicate the lag in visa approvals related to the additional procedures and time spent by other visa approval offices (domestic and foreign) before prospective H-2A workers are given the final approval to travel to the U.S. to commence work.

The plots in Figure 1 indicate some growth realized in H-2A labor visa approvals in recent years. During the last three years (2015–2017), these growth rates range from approximately 20 percent to 24 percent. In 2017, DOL reported H-2A labor certifications that broke the 200,000 mark for the first time. DOL also reports that its processing efficiency has increased considerably in more recent years, as 95 percent to 97 percent of complete applications were processed timely (i.e., within 30 days before the start date of need).

However, in spite of these encouraging developments, the H-2A program has supplied only about 12 percent to 18 percent of the total hired farm labor in the country during the last three years. As can be gleaned from Figure 1, the proportion of H-2A workers to total hired farmworkers has been increasing steadily during most of the 10-year period, but the expectations for this program's reliability in supplying a more significant proportion of farm employment remain high.

## FARMERS' H-2A PATRONAGE ISSUES

A survey was conducted among farmers in late 2015 as part of a project funded by the Southern Sustainable Agriculture and Research Education (SARE) designed to collect the farmers' perspective on the implementation of the H-2A visa program. The survey was directed toward producers in North Carolina and Georgia, two states that consistently ranked in the top five states in H-2A labor applications during the last five years. The survey instrument collected farmers' assessment of their previous H-2A hiring experiences, evaluation of the H-2A workers' quality of work, and effectiveness of the program in meeting their labor demands.

### The Waiting Period

Survey results indicate that the documentary preparation phase is the least serious of all timing issues, as about half of the respondents needed only five days or less to complete requirements, while about 20 percent needed a month or two to comply (Figure 2). The majority have either partially or fully employed the services of external consulting agents who assisted with document preparation, with 77 percent of them requiring the agents' full assistance. Jim Phillips of California validates this practice through his experience of hiring a contractor for 120 Mexican guest workers he needed for his farm businesses — which he describes as "a little bit more expensive" (Harkinson, 2017).

The filing and approval phase takes a little bit longer as the applications of about 70 percent of the respondents were processed for about 30 days before labor certifications were issued (Figure 2). A foreign labor certification decision is actually mandated by law to be issued "no later than 30 days before the employer's start date of need" (Office of Foreign Labor Certification, 2015). According to annual H-2A program reports, compliance rate for this mandate has ranged from 85 percent to 97 percent since 2011, except in 2013 when only 69 percent of the applications were approved in a timely manner (Employment and Training Administration, 2011–2016). A letter written to the DOL from six senators cited specific reasons for denials or delays in approval of applications that include "minor discrepancies related to language or officers applying an unreasonable degree of scrutiny" (Cockerham, 2012).

The foreign workers' arrival in the country, however, was delayed by approximately two more months from the time certifications were issued (Figure 2). As implemented, the DOL approval of the foreign labor certification is only a preliminary step in a complicated procedure involving multiple federal agencies, such as the Department of Homeland Security (DHS) that approves the petition, the Department of State at a U.S. Embassy/Consulate in the foreign workers' home country that approves the H-2A visa, and the U.S. Customs and Border Protection (CBP) that grants admission at a U.S. port of entry (USCIS, 2017).

In an industry that deals with perishable commodities and in which the timing of most tasks is defined by environmental variability, market opportunities, and other risk and uncertainty factors, the availability of the much-needed labor inputs is crucial to business survival and success. As a South Georgia farmer once exclaimed, "A week or two is a delay. Two months is you've lost your crop" (Sheinin, 2016). Georgia Agriculture Commissioner Gary Black sums up the plight of farmers as "abiding by the law (but) our government is failing them" (Sheinin, 2016).

### The Costs of Waiting

The hiring of foreign workers to fill the vacated farm positions comes at a high cost that can be broken down into opportunity costs, realized crop losses, and actual incremental expenditures incurred during and after the application process. Approximately 69 percent of the surveyed farmers, for instance, declared that their hiring costs increased their business expenses by at least 25 percent (Figure 3). The itemized costs include job search expenses, application fees, regulatory fees, and benefits that the employers are mandated by law to provide to workers, such as transportation, housing, food, and fringe benefits. These workers' wages are also regulated by minimum rates set by the government. As one farmer complained, "Their pay is often higher than the state's minimum wage. In New York, it's an extra $2 an hour" (Rosenthal, 2016).

The only tradeoff possibility for these incremental costs lies among the foreign workers employed — on their job performance once they are hired. Survey responses indicate that more than half of the farmers noted increases in labor efficiency and productivity, including 47 percent who acknowledged labor productivity improvements of at least 25 percent (Figure 3). About 34 percent, however, claimed that no labor productivity changes were realized among their H-2A workers.

The farmers' assessment of their overall business condition incorporates cost and labor productivity considerations (Figure 3). One-third of the survey respondents reported overall losses in their farm businesses even after securing the services of H-2A workers. In contrast, about 40 percent realized at least 25 percent growth in their business profits even after enduring the rigorous and costly process of hiring H-2A workers.

## THE NEED FOR MORE REFORMS

Some farms may have fortunately endured the challenge of sustaining their business operations with patience, persistence, and adept business management skills to offset the effects of delayed arrival of needed farm workers, missed market opportunities, and other demands of their volatile business environment. But such trend may not persist much longer. The H-2A program's implementation guidelines, once labeled as "confusing and painful" (Rosenthal, 2012), need to be revisited and amended if the program is envisioned to indeed benefit the farm industry. Farmer groups have charged that the current program has been "bureaucratic and insensitive to the (farm) industry's need" and have called for simplification of current procedures (Ong, 2015). Specific requests include suggestions for allowing the filing and processing of applications to be conducted electronically. Others have also proposed a fast-track evaluation process for workers who have already regularly worked in the country for several years (Sheinin, 2016).

## LEGISLATIVE EFFORTS

Some legislators have included this farm labor issue in their agendas. U.S. Rep. Rick Allen of Georgia reintroduced the Better Agriculture Resources Now (BARN) Act that transfers the responsibility of H-2A certification from DOL to the Department of Agriculture, which arguably is more familiar with the farmers and their business conditions and "time-sensitive" operations. The Act also proposes, among other things, to eliminate the 50 percent rule and set wages at no more than 115 percent of the minimum wage. This proposal is still awaiting further legislative action.

Reps. Chris Collins and Elise Stefanik (NY-21) also introduced the Family Farm Relief Act of 2017 that supports Rep. Allen's proposed transfer of the H-2A Agricultural Visa program from DOL to DA. Their proposal also addressed some application issues as they suggested that visa applicants be allowed to fill out H-2A applications on paper or online. They also demanded a more user-friendly online system and the removal of burdensome requirements on advertising and prevailing practice surveys. This proposed legislation is also pending and awaiting further action.

The Congress' Judiciary Committee Chairman Robert Goodlatte of Virginia also proposed the replacement of H-2A with the H2C program. In addition to supporting the move of certification responsibility from DOL to DA, Goodlatte's proposal also would allow workers to stay with employers year-round, with an initial stay of 36 months. This proposed bill would expand the definition of "agricultural labor" to extend visas to workers in industries requiring year-round workers (such as forestry, dairy, and meat-processing industries). This bill also proposes that undocumented farm workers currently in the U.S. should be allowed to apply for H2C visas. It also has some cost-cutting proposals that include the relaxation of the free transportation and housing benefits for workers under the H-2A program. The AEWR is proposed to be repealed as wages are proposed to be calculated based on some percentage of the federal or state minimum wage, rather than prevailing wages. This bill was introduced in the House Judiciary Committee in October 2017 and voted on (17 yeas and 16 nays). It is currently being modified as requested during the House committee voting.

## WHAT NOW?

Meanwhile, as the farm sector awaits favorable actions on these legislative proposals, farmers must contend with existing guidelines of the program. The economic issues surrounding the hiring of H-2A workers are always two-sided. As farmers clamor for cost reductions to increase the viability potential of their farm businesses, workers and civil rights advocates rally for their retention as they demand that workers' welfare should be ensured and upheld.

There are, however, some neutral issues that need to be resolved to produce favorable consequences both to farmers and workers. Easier, quicker, and more convenient processing requirements that minimize delays and bureaucratic procedures can be less debatable issues to rally for. When these are resolved, then a more deliberate reconciliation of farmers' and workers' economic interests is needed to reach a compromise. Only then will the program be truly reliable and attract higher patronage among farmers.

The reality at the farm level, however, remains clear and unchanged. Even if not all the direct financial costs stipulated under the program can be substantially reduced, farm businesses clamor for program reforms that should address the eradication of opportunity costs associated with postponed production, harvesting, or marketing operations caused by delayed availability of H-2A workers. The survival of sectors in the farm industry most vulnerable to the farm labor gap condition lies in the responsiveness of policymakers to the farmers' appeals for more beneficial changes in the implementation of the H-2A program. After all, if the program falters in meeting the farmers' needs at the most opportune time, where else would farmers turn? How else would farmers and their businesses survive?

## REFERENCES

Burke, G. 2010. "Despite economy, Americans don't want farm work." *Associated Press*. http://news.yahoo.com/s/ap/us_immigration_jobs/. [Accessed on September 27, 2010.]

Carter, C. 2011. "Spring labor shortage cost Georgia almost $400 million in lost crops and revenues." *The Produce News*. http://producenews.com/9-news-section/story-cat/6621-spring-labor-shortage-cost-georgia-almost-400-million-in-lost-crops-and-revenues. [Accessed on August 1, 2017].

Cockerham, S. 2012. "Seasonal farm worker visa program frustrates growers." *McClatchy DC Bureau*. http://www.mcclatchydc.com/news/politics-government/ article24729139.html. [Accessed on January 27, 2017].

Employment and Training Administration. 2011–2016. H-2A *Temporary Agricultural Labor Certification Program – Selected Statistics,* FY 2011–2016. Department of Labor (DOL), Washington, DC.

Escalante, C.L., S.L. Perkins, and F.I. Santos. 2011. "When the seasonal foreign farm workers are gone." *Journal of the American Society of Farm Managers and Rural Appraisers*. 74: 83–96.

Farmworker Justice. 2010. "H-2A Guest worker Program." *Farmworker Justice*. Online. http://www.fwjustice.org/guest-worker-programs/h-2a. [Accessed on December 12, 2011].

Harkinson, J. 2017. "Trump's Plan to Make America Great Again Using Cheap Foreign Labor." *Mother Jones*. http://www.motherjones.com/politics/2017/03/trump-guestworker-H-2A-visa-farm-workers-immigration/. [Accessed on April 11, 2017].

Levine, L. 2004. "Farm Labor Shortages and Immigration Policy." Congressional Research Service. Washington, DC.

Luo, T., and C.L. Escalante. 2017. "U.S. farm workers: What drives their job retention and work time allocation decisions?" *The Economic and Labour Relations Review*, 28, 2: 270–293.

Martin, P. L. 2014. *Importing poverty: Immigration and the changing face of rural America.* Yale University Press, New Haven, CT.

Mayer, G. 2008. *Temporary Farm Labor: The H-2A Program and the U.S. Department of Labor's Proposed Changes in the Adverse Effect Wage Rate (AEWR).* Congressional Research Service, RL34739.

McKissick, J.C., and S.P. Kane. 2011. *An evaluation of direct and indirect economic losses incurred by Georgia fruit and vegetable producers in spring 2011.* Working Paper, Center for Agribusiness and Economic Development, University of Georgia, Athens, GA.

Office of Foreign Labor Certification. 2015. Annual Report. Department of Labor (DOL), Washington, DC.

Ong, Y. 2015. "The H-2A problem: Why a perfectly legal farm-worker visa program isn't being used more." *United Press International*. https://www.upi.com/Top_News/ US/2015/03/05/The-H-2A-problem-Why-a-perfectly-legal-farmworker-visa-program-isnt-being-used-more/7521425481876/. [Accessed on January 27, 2017].

Rivoli, D. 2011. "Alabama Immigration Law: Worker-Strapped Farm Groups Doubt Prisoner Ready." *International Business Times*. http://www.ibtimes.com/alabama-immigration-law-worker-strapped-farm-groups-doubt-prisoner-remedy-322016. [Accessed on August 1, 2017].

Rosenthal, L. 2016. "Farmers Wait, and Wait, for Guest Workers amid H-2A Visa Delays." *National Public Radio*. http://www.npr.org/sections/thesalt/2016/05/ 28/479633481/farmers-wait-and-wait-for-guest-workers-amid-h-2a-visa-delays. [Accessed on April 11, 2017].

Rusiana, H., and C.L. Escalante. 2016. *H-2A Bulletin No. 1: Southeastern Farmers' Application Experiences and Perceptions of the Farm Guest Worker Visa (H-2A) Program.* UGA Outreach Bulletin, Department of Agricultural and Applied Economics, University of Georgia.

Rusiana, H., and C.L. Escalante. 2016. *H-2A Bulletin No. 2: Southeastern Farmers' Cost and Labor Productivity Assessments of the Current Farm Guest Worker Visa (H-2A) Program.* UGA Outreach Bulletin, Department of Agricultural and Applied Economics, University of Georgia

Santos, F.I., and C. L. Escalante. 2010. *Farmers' Business Expectations and Strategies under Immigration-Related Changes in Farm Labor Market Conditions: A Survey of Southeastern Organic and Conventional Farm Businesses.* AGECON-10-002. Department of Agricultural and Applied Economics, University of Georgia.

Seid, J. 2006. "Immigration reform could cost you." *CNN Money*. http://money.cnn.com/2006/04/28/smbusiness/immigration_reform_prices. [Accessed on December 12, 2011].

Sheinin, A.G. 2016. "Losses grow for Georgia farmers waiting on feds to OK foreign workers." *Atlanta Journal Constitution*. http://www.myajc.com/news/state--regional-govt--politics/losses-grow-for-georgia-farmers-waiting-feds-foreign-workers/qEax1odfXFG3w1RO3mSh6L/. [Accessed on June 20, 2017].

Souza, C. 2010. "Farmers say new H-2A rule adds cost, complexity." *California Farm Bureau Federation*. http://cfbf.info/agalert/AgAlertStory/. [Accessed on May 27, 2010].

Stallman, R. 2010. "New H-2A regulations will make it harder to put food on America's tables." *Natural Resource Report*. http://naturalresourcereport.com/ 2010/02/new-h-2a-worker-visa-regulations-rile-farmers/. [Accessed on May 17, 2010].

United States Citizenship and Immigration Services (USCIS). 2017. *H-2A Temporary Agricultural Workers*. Department of Homeland Security. https://www.uscis.gov/working-united-states/temporary-workers/h-2a-temporary-agricultural-workers. [Accessed on August 1, 2017].

United States Department of Agriculture – National Agricultural Statistics Service. 2008–2015. *Farm Labor*. United States Department of Agriculture – National Agricultural Statistics Service, Washington, DC. http://usda.mannlib.cornell.edu/MannUsda /viewDocumentInfo.do?documentID=1063. [Accessed on October 21, 2016].

United States Department of Labor (DOL). 2008–2015. "H-2A Program Application Data." *Foreign Labor Certification*. OFLC Performance Data http://www.foreignlaborcert. doleta.gov/performancedata.cfm. [Accessed on October 21, 2016].

United States General Accounting Office (GAO). 1997. *H-2A Agricultural Guest worker Program: Changes Could Improve Services to Employers and Better Protect Workers*. Report to Congressional Committees, GAO/HEHS-98-20.

Zahniser, S., Hertz, T., Dixon, P., and M. Rimmer. 2012. "Immigration policy and its possible effects on U.S. agriculture and the market for hired farm labor: a simulation analysis." American *Journal of Agricultural Economics* 94:477–482.

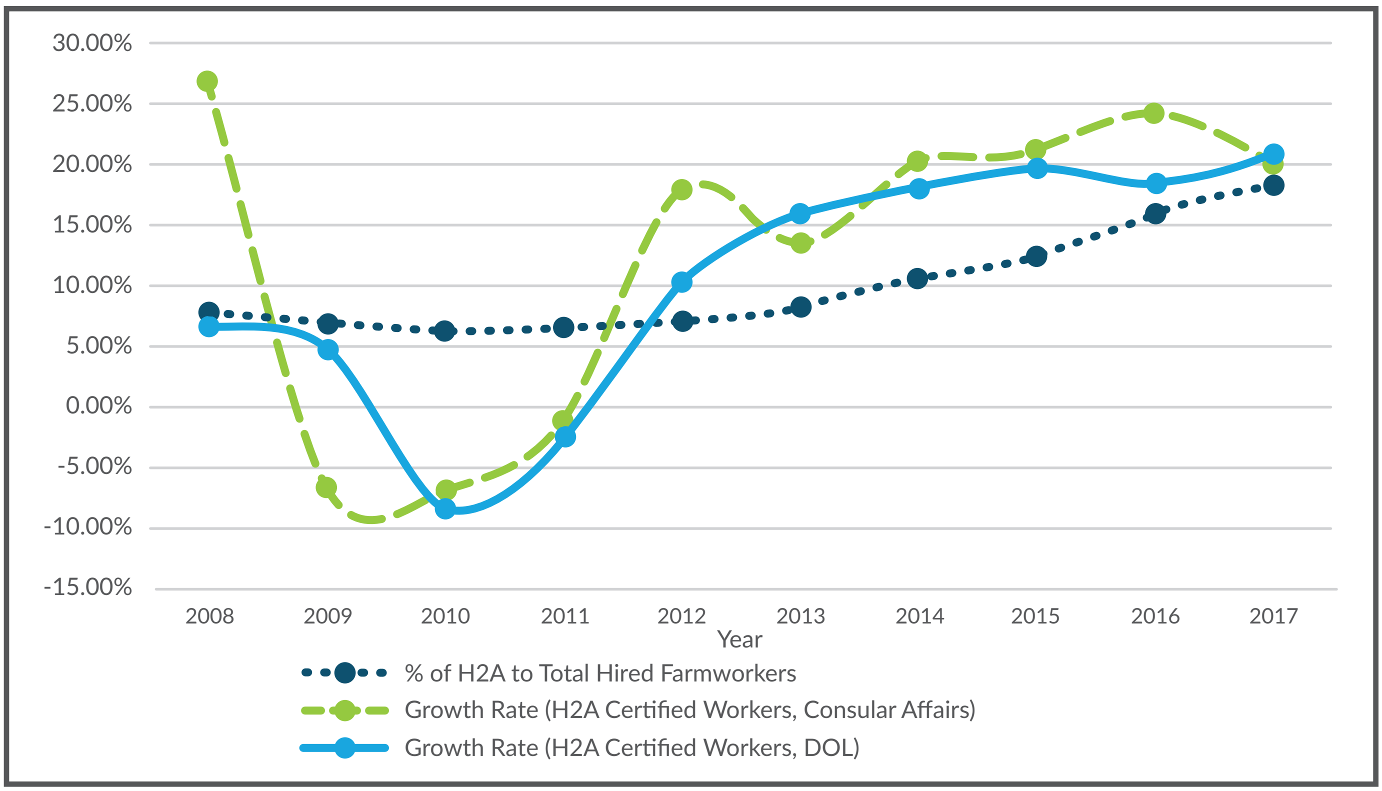


Figure 1. Growth Rates and Proportion of H-2A to National Total Hired Labor, 2008–2017

Sources: Department of Labor (DOL) and Office of Consular Affairs

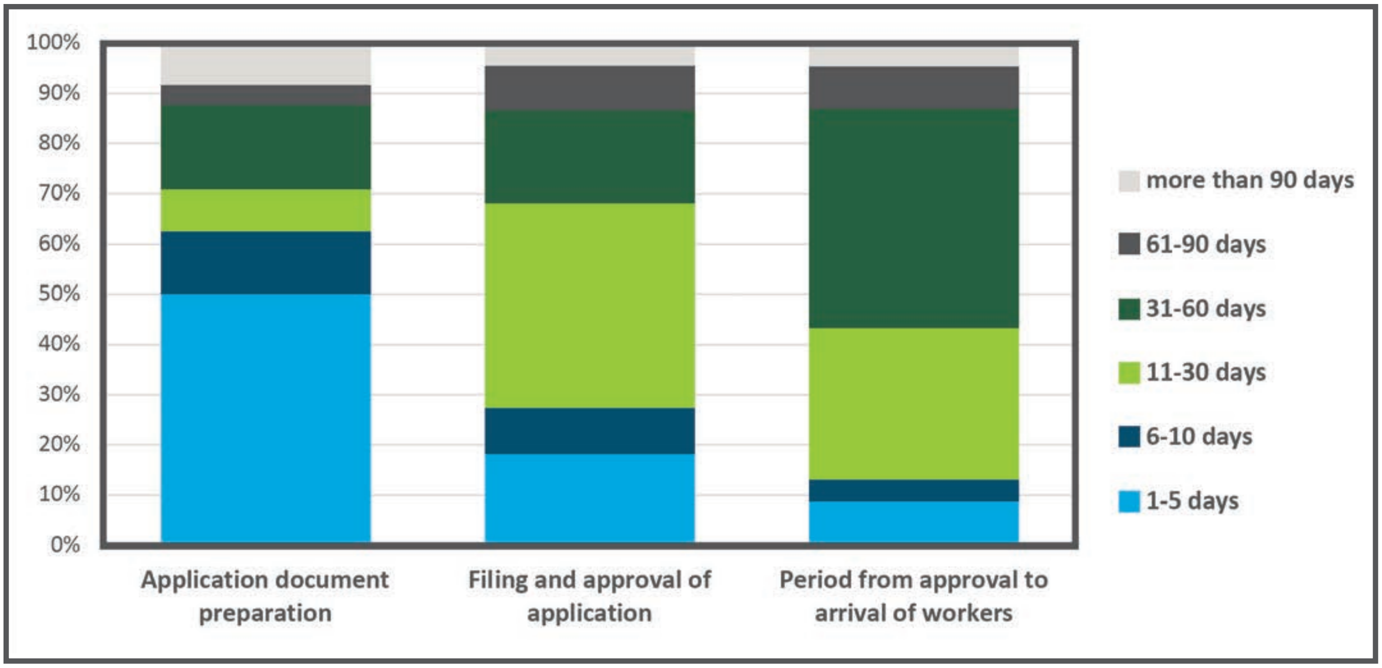


Figure 2. Length of Preparation, Processing, and Approval of H-2A Visa Applications

Source: Rusiana and Escalante, H-2A Outreach Bulletin No. 1, University of Georgia

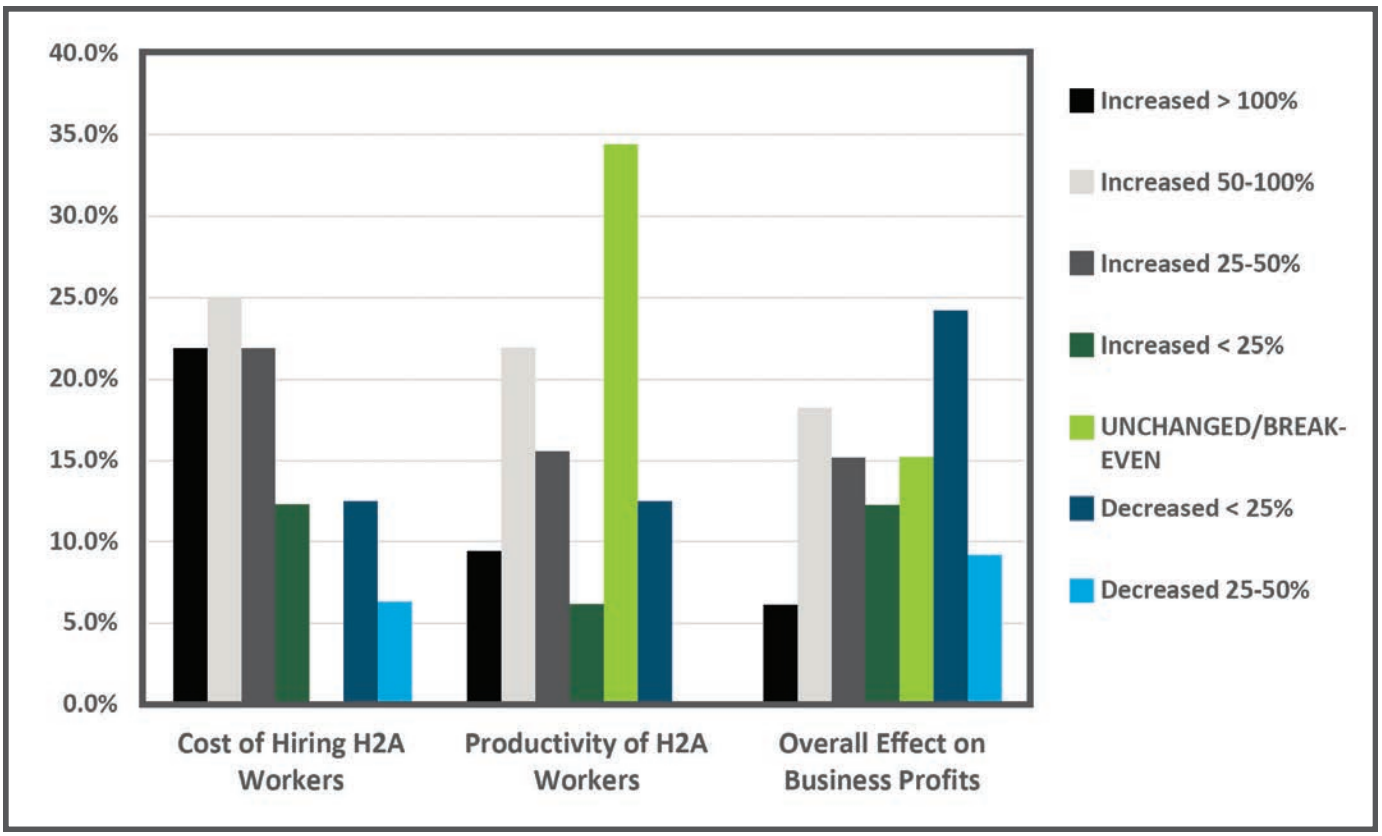


Figure 3. Effects of H-2A Hiring Decisions on Costs, Labor Productivity, and Business Profits

Source: Rusiana and Escalante, H-2A Outreach Bulletin No. 2, University of Georgia

# Declining Liquidity in Iowa Farms: 2014–2017

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### Abstract

*The goal of the present study is to describe the evolution of financial liquidity in Iowa farms for 2014–2017, using a unique panel of 220 mid-scale commercial farms. Farms with vulnerable liquidity ratings increased from 33.2 percent in December 2014 to 45.0 percent in December 2017. On average, farms lost $244 of working capital per acre over that period, but farms with vulnerable liquidity ratings in December 2017 lost almost 60 percent more than that, or $388. Average farm size, machinery investment per acre, farm net worth per acre, debt-to-asset ratio, and age of operator were not significantly different across liquidity-rating categories.*

## INTRODUCTION

Average accrued net farm income in Iowa, the largest corn producer state and the second largest soybean producer state in the United States, declined by 89 percent from its peak at $243,072 in 2012 to $27,927 in 2015, before recovering to $57,928 in 2017 (Plastina & Johanns, 2018). Because of this erosion in farm profitability, a deterioration of the overall financial health of the farm sector ensued, in terms of both lower average liquidity[1] levels and higher average farm debt levels (Figure 1). In particular, the average current ratio[2] for Iowa farms peaked in 2012 at 7.08, and it has since declined to 2.74 in 2017, its lowest level since 2001 when it reached 2.46 (Plastina & Johanns, 2018). Similarly, the average working capital[3] per dollar of gross revenue declined from 0.78 in 2013 to 0.55 in 2017, the lowest level since 2011 (0.43) (Plastina & Johanns, 2018).

However, understanding the actual distribution of liquidity across farms is more relevant than measuring the liquidity of an average farm. This is particularly true for a low-commodity-price environment with sticky costs that puts extra strain on farms' cash-flow budgets. The goal of this article is to describe the evolution of financial liquidity in Iowa farms between 2014 and 2017. This report is expected to inform the policy discussion on the appropriateness of the current farm safety net, provide valuable insights to lenders and regulators about the potential systemic risk in agricultural production, and provide benchmarks for farms and agricultural stakeholders to design appropriate liquidity management strategies.

The novelty of this article stems from the use of detailed farm records collected by the Iowa Farm Business Association (IFBA), an independent association, managed and controlled by its farmer-members.[4] Because the IFBA data are collected through multiple interactions through time between farmer-members and regional consultants from the same association, the quality of the enumeration is expected to be higher than that of similar data sets collected through a single annual interaction between enumerators and farmers (such as the Agricultural Resource Management Survey (ARMS) conducted jointly by the National Agricultural Statistics Service and the Economic Research Service of the U.S. Department of Agriculture).

At calendar year-end, the liquidity of each farm is evaluated using its current ratio, and the farm is assigned one of the following liquidity ratings: vulnerable, normal, or strong. The evolution of financial liquidity in Iowa is assessed by evaluating the number of farms in each liquidity-rating category through time, as well as their average current ratio and average working capital per acre. Net worth per acre, machinery investment per acre, farm size, and age of the operator are also evaluated to better understand how the average farm in each liquidity-rating category changed through time. This article extends and refines the analysis conducted by Plastina (2016), by incorporating two years of additional data and expanding the list of variables used to characterize farms.

The next section explains the sample selection process, discusses its representativeness, and provides details on the valuation methods and their impact on our solvency measures. A methodological section follows, explaining the liquidity ratings. After presenting the results, we provide practical perspectives for farmers, lenders, and policy-makers in the concluding section.

## DATA

The 220 farms analyzed in this study were selected from the IFBA database based on the availability of complete and detailed financial statements for the years 2014 to 2017. Because the IFBA data are not collected using survey sampling methods, they are not representative of the population of Iowa farms. However, after classifying the sample farms according to their Gross Farm Cash Income using the typology proposed by the USDA's Economic Research Service (2017), it becomes apparent that the IFBA data is comprised mostly of mid-scale farms (Figure 2). Furthermore, sample farms are usually larger than 180 acres and operated by people 45 years old or older (Table 1). In summary, the sample farms are believed to be representative of mid-scale commercial farms largely managed by experienced farmers.

Financial statements prepared by IFBA consultants use a mix of valuation strategies to track farm financial performance: current assets are valued at their market value, but some intermediate and all long-term assets (such as machinery and land, respectively) are valued at their cost (or book) value. If a cost value is not available, then the asset is assigned a value equivalent to certain percent of the market value the first time it is recorded, and its value is reduced thereafter by a fixed percentage if the asset is depreciable. Therefore, solvency measures (such as net worth) or measures of investments (such as machinery investment per acre) are not affected by changes in market prices or by their tax basis.

## METHODOLOGY

To ensure the comparability of financial liquidity across farms of different sizes, the assessment is conducted using the current ratio (CR), calculated as current assets divided by current liabilities. While dairy farms or other farms that have continuous sales throughout the year can safely operate with lower CRs, operations that concentrate sales during several periods each year (such as cash grain farms) need to strive for higher CRs, especially near the beginning of the crop year.

According to the Farm Financial Scorecard (Becker et al., 2014), a CR above 1.7 indicates a *strong* liquidity position; a ratio below 1.3 indicates a *vulnerable* liquidity position, and a ratio between 1.3 and 1.7 is *normal* and indicates that liquidity should be kept under close watch. Based on its calendar year-end CR and the thresholds recommended by Becker et al. (2014), we assign each farm one of the three liquidity ratings: vulnerable, normal, or strong. To avoid outliers in the sample, only farms with non-negative current ratio values below 50 were selected.

The distribution of counts of farms across the three categories is used as an indicator of the overall financial liquidity situation among mid-scale commercial farms in Iowa at calendar year-end. Selected indicators are reported for each category to characterize the various groups: working capital per acre, farm net worth per acre, farm size, age of the operator, and machinery investment per acre.

Working capital per acre (WKA), calculated as the ratio of the difference between current assets and current liabilities to the number of acres in the operation, is a complementary measure of liquidity to the CR that indicates the dollar amount of liquid assets to cancel short-term obligations on a per acre basis. A negative WKA indicates that liquid assets are insufficient to cover current liabilities, and the need for extra cash. The larger the WKA, the lower the need for extra cash over the following 12 months.

Farm net worth per acre (NWA), calculated as the ratio of the difference between total farm assets and total farm liabilities to the number of acres in the operation, is a relative measure of solvency that indicates the dollar amount of equity available in the operation on a per acre basis. The larger the NWA, the more likely the operation is to have access to lines of credit using its own equity as collateral to finance short-term gaps in working capital.

A complementary measure of financial solvency is the debt-to-asset ratio (DTA), calculated as the ratio of total liabilities to total assets. The higher (lower) the DTA, the higher (lower) the leverage of the operation and therefore the lower (higher) the relative equity in the business.

Farm size is measured as the number of cropland acres per operation, and is included in the analysis to evaluate whether farms with vulnerable liquidity ratings tend to be smaller than other farms.

Age of the operator is used as an imperfect indicator of farming experience, and farms with vulnerable liquidity ratings are expected to be operated by younger farmers than other farms.

Machinery investment per acre is included in the analysis to evaluate whether machinery investment is associated with liquidity ratings. Anecdotal evidence suggests that financially stressed farms tend to have overinvested in machinery in recent years.

The count of farms that switched categories across years is used as an indicator of the change in the liquidity situation for Iowa farms.

## RESULTS

Almost half (44.5 percent) of the farms had a strong liquidity rating by December 2014, and one-third (33.2 percent) had a vulnerable liquidity rating (Table 2). By December 2015, the percent of farms with vulnerable liquidity ratings increased by 9.1 percentage points, and vulnerable farms accounted for a slightly larger share of the sample than farms with strong liquidity ratings: 42.3 percent versus 39.1 percent, respectively. By December 2016, almost half (46.4 percent) of the farms had vulnerable liquidity ratings, while the shares of the other two groups continued to decline. By December 2017, there was a slight reduction in the share of farms with vulnerable liquidity (from 46.4 percent to 45.0 percent), and a 7.3 percentage points in the share of farms with normal liquidity ratings, resulting from a large reduction in the share of farms with strong liquidity. By direct comparison of the shares of the three groups in December 2014 and December 2017, it becomes apparent that the financial liquidity of mid-scale commercial farms in Iowa experienced a strong deterioration, going from having almost half of the sample classified into the strong category to having almost half of the sample classified into the vulnerable category.

The evolution of the average value of the CR (Table 2) for the group of farms with strong liquidity ratings (that change in composition over the years) suggests that its average liquidity declined by 16 percent (from 6.2 to 5.22) between December 2014 and December 2017. However, the difference in means is not statistically significant (p-value=0.22). Because of the use of fixed thresholds to classify farms according to their CR, the average value of the CR for the vulnerable and strong liquidity categories remained stable through time.

The means of the other variables characterizing farms in each category listed in Table 2 (farm size, age of operator, investment in machinery, debt-to-asset ratio, and farm net worth per acre) are numerically different across categories and through time, but the differences are not statistically significant at the 10 percent significance level. Therefore, we are not able to associate particular farm characteristics to a higher or lower risk of falling into the vulnerable liquidity category.

The average loss in WKA across all farms in the sample amounted to $146.5 in 2015, $78.4 in 2016, and $19.3 in 2017, accumulating a $244.2 loss over the entire period (Table 3). The difference between average WKA losses in 2015 and 2017 is statistically significant at the 10 percent level of confidence, as indicated by the non-overlapping confidence intervals in Table 3.

Farms with vulnerable liquidity ratings in December 2017 accumulated an average loss of $387.9 in WKA since 2014. In 2015 and 2016, the three categories showed average losses in WKA, but in 2017, only the vulnerable category continued to lose WKA. However, on an annual basis, the only significant difference (at the 10 percent significance level) is that between the mean loss in WKA by vulnerable farms versus the mean loss in WKA by strong farms in 2017.

## CONCLUSIONS

This article describes the evolution of financial liquidity across Iowa farms over 2014–2017, using a unique panel of farm financial statements collected by the Iowa Farm Business Association (IFBA).

The share of farms with vulnerable liquidity ratings increased from 33.2 percent in December 2014 to 45.0 percent in December 2017. On average, farms lost $244.2 of working capital per acre over that period, but farms with vulnerable liquidity ratings accumulated a loss of $387.9. More than two in five farms run the risk of not being able to pay off their obligations as they become due over the course of 2018.

This study does not find statistical evidence that farm characteristics — such as farm size, average machinery investment per acre, farm net worth per acre, debt-to-asset ratio, and age of operator — differ significantly across liquidity-rating categories or years. Further research including more detailed variables in the analysis should be pursued to evaluate whether specific farm traits affect the likelihood of facing larger liquidity risks.

The results of this study serve as a unique guide to understand the extent of financial stress across agricultural operations in Iowa, which is particularly relevant in the current context of low commodity prices, where a new Farm Bill and a changing trade scenario could potentially curtail the demand for agricultural products from Iowa. Results are expected to serve as benchmarks for Iowa and Midwest producers and to be incorporated in the process of farm financial planning. For example, lenders could use the information presented in this article to discuss in an impersonal way the recent deterioration of overall liquidity indicators and the importance of cash flow budgeting for farms of all sizes and operators of all ages.

## ENDNOTES

1. Liquidity indicates the degree to which debt obligations coming due over the following year can be paid from cash or assets that soon will be turned into cash, and is typically measured by the current ratio and the working capital.
2. The current ratio is calculated as the ratio of current assets to current liabilities, and measures the number of dollars in current assets per dollar of current liabilities.
3. Working capital is calculated as the difference between current assets and current liabilities.
4. More information on the IFBA is available online at http://www.iowafarmbusiness.org/services.html.

## REFERENCES


Becker, K., D. Kauppila, G. Rogers, R. Parsons, D. Nordquist, and R. Craven. 2014. “Farm Finance Scorecard.” Center for Farm Financial Management, University of Minnesota. https://www.cffm.umn.edu/Publications/pubs/FarmMgtTopics/FarmFinanceScorecard.pdf.

Economic Research Service. 2017. “America’s Diverse Family Farms. 2017 Edition.” USDA Economic Information Bulletin Number 185. December. https://www.ers.usda.gov/publications/pub-details/?pubid=86197.

Plastina, A. 2016. “Iowa Farms: From Strong to Vulnerable in a Year?” Iowa State University Extension and Outreach FM 1890. https://www.extension.iastate.edu/agdm/wholefarm/pdf/c1-12.pdf.

Plastina, A., and A. Johanns. 2018. “Iowa Farm Costs and Returns.” Iowa State University Extension and Outreach. Ag Decision Maker File C1-10. https://www.extension.iastate.edu/agdm/wholefarm/html/c1-10.html


**Table 1. Sample farms by size (in acres) and age of principal operator.**

| | IFBA Farms | | | IFBA Farms | |
|---|---|---|---|---|---|
| **Farm Size (Acres)** | **N** | **%** | **Age Group** | **N** | **Percent** |
| a) 1 to 9 | 0 | 0 | a) Under 25 | 1 | 0.45 |
| b) 10 to 49 | 2 | 0.91 | b) 25 to 34 | 8 | 3.64 |
| c) 50 to 179 | 6 | 2.73 | c) 35 to 44 | 11 | 5 |
| d) 180 to 499 | 67 | 30.45 | d) 45 to 54 | 61 | 27.73 |
| e) 500 to 999 | 84 | 38.18 | e) 55 to 64 | 89 | 40.45 |
| f) 1000 and up | 61 | 27.73 | f) 65 and up | 50 | 22.73 |
| **Total Observations** | **220** | **100** | **Total Observations** | **220** | **100** |
| **Average Size** | **814.53** | | **Average Age** | **56.85** | |

**Table 2. Distribution of farms by Liquidity Rating and year, and selected characteristics by group**

| Variable | Year | Current Ratio Status | | |
|---|---|---|---|---|
| | | Vulnerable (CR<=1.3) | Normal (1.3<CR<=2.0) | Strong (CR>2) |
| Percent of Farms in Sample | 2014 | 33.2 | 22.3 | 44.5 |
| | 2015 | 42.3 | 18.6 | 39.1 |
| | 2016 | 46.4 | 15 | 38.6 |
| | 2017 | 45 | 22.3 | 32.7 |
| Average Current Ratio | 2014 | 0.9 (0.26) | 1.6 (0.17) | 6.2 (6) |
| | 2015 | 0.91 (0.28) | 1.59 (0.2) | 5.83 (6.08) |
| | 2016 | 0.91 (0.27) | 1.66 (0.2) | 5.5 (5.43) |
| | 2017 | 0.87 (0.27) | 1.6 (0.21) | 5.22 (5.12) |
| Average Debt-to-Asset Ratio | 2014 | 0.6 (0.31) | 0.44 (0.22) | 0.25 (0.18) |
| | 2015 | 0.63 (0.29) | 0.4 (0.21) | 0.25 (0.17) |
| | 2016 | 0.63 (0.28) | 0.41 (0.25) | 0.23 (0.16) |
| | 2017 | 0.65 (0.33) | 0.44 (0.23) | 0.23 (0.18) |
| Average Farm Size (in acres) | 2014 | 761 (544) | 857 (609) | 833 (539) |
| | 2015 | 846 (596) | 699 (505) | 836 (532) |
| | 2016 | 795 (554) | 887 (691) | 809 (501) |
| | 2017 | 809 (586) | 836 (552) | 808 (522) |
| Average Age of Operator | 2014 | 54.3 (11) | 57.1 (12.4) | 58.1 (9) |
| | 2015 | 55 (11.3) | 56.7 (12.3) | 58.4 (8.6) |
| | 2016 | 54.7 (12) | 57.5 (10.1) | 58.6 (8.4) |
| | 2017 | 55.7 (11.3) | 55.4 (11.5) | 58.7 (8.7) |
| Average Working Capital per Acre | 2014 | -108.5 (258.6) | 679.7 (1091.4) | 769.7 (601.3) |
| | 2015 | -23.7 (645.6) | 292.1 (137.8) | 686.5 (475.2) |
| | 2016 | -126.7 (407) | 335.3 (168.3) | 622.2 (369.8) |
| | 2017 | -146.6 (468.6) | 377.1 (326.8) | 594.7 (325.3) |
| Average Farm Net Worth per Acre | 2014 | 2023 (4044) | 2816 (2483) | 2936 (1942) |
| | 2015 | 1667 (1635) | 3302 (4997) | 3014 (1930) |
| | 2016 | 1820 (3434) | 2500 (2053) | 3079 (1827) |
| | 2017 | 1817 (3594) | 2550 (1867) | 3008 (1889) |
| Average Machinery Investment per Acre | 2014 | 526 (305) | 513 (255) | 502 (246) |
| | 2015 | 491 (264) | 514 (285) | 513 (289) |
| | 2016 | 504 (271) | 537 (282) | 501 (311) |
| | 2017 | 516 (271) | 565 (348) | 459 (259) |

Note: Standard deviations in parenthesis.

| Table 3. Average changes in working capital per acre by Liquidity Rating in 2017 | | | |
|---|---|---|---|
| **Liquidity Rating in 2017** | **Period** | | |
| | **Dec2014-Dec2015** | **Dec2015-Dec2016** | **Dec2016-Dec2017** |
| Vulnerable (CR<=1.3) | -191.2 (808.6) | -144.5 (737.3) | -52.3 (246.3) |
| | [-326.8; -55.5] | [-268.2; -20.8] | [-93.6; -10.9] |
| Normal (1.3<CR<=2.0) | -157.0 (364.0) | -16.3 (288.5) | 15.1 (328.9) |
| | [-244.2; -69.8] | [-85.4; 52.8] | [-63.7; 93.9] |
| Strong (CR>2) | -78.6 (172.5) | -30.6 (166.9) | 2.2 (151.5) |
| | [-112.5; -44.8] | [-63.4; 2.2] | [-27.6; 31.2] |
| All farms | -146.5 (576.4) | -78.4 (522.4) | -19.3 (243.3) |
| | [-247.7; -45.3] | [-170.1; 13.4] | [-62.1; 23.4] |

Note: Standard deviations in parenthesis; 10% confidence intervals in square brackets.

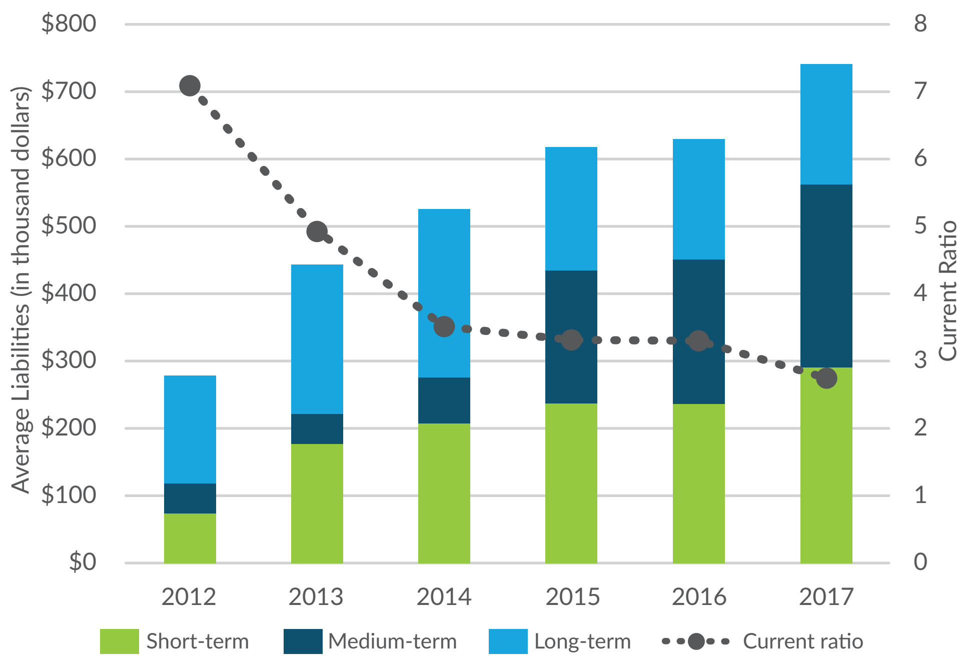


Figure 1. Current Ratio and Average Liabilities of Iowa Farms

# Effectiveness of Paperless Communication from the USDA Farm Service Agency

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## Abstract

*The USDA Farm Service Agency replaced paper mailings with GovDelivery electronic communication in order to increase efficiency and reduce costs. This case study presents evidence from one state indicating a perception among local FSA officials that GovDelivery does not allow them to effectively serve their constituents. A gap in reliable rural Internet service and low usage of smartphones in place of rural broadband may contribute to the extremely low open rates for GovDelivery email notifications. Findings suggest that electronic-only communication does not allow the agency to effectively engage with farm owners, operators, and managers.*

## INTRODUCTION

In its May 2012 state newsletter, the Illinois Farm Service Agency announced that with the development of the GovDelivery email system, all USDA Farm Service Agency offices were "moving toward a paperless operation" by replacing printed and mailed information (such as county newsletters) with "notices, newsletters, and electronic reminders" distributed through GovDelivery (IL FSA, 2012, p. 1). This move was presented as a way for the agency "to work smarter and be more efficient," and farmers were instructed to provide an email address to their local FSA office if they wanted to receive the electronic county newsletter that took the place of the previous paper newsletters they were accustomed to receiving (IL FSA, 2012, p. 1). This transition came in response to a congressional mandate that the agency cut its operating costs; according to Kent Politsch, USDA Farm Service Agency Chief of Public Affairs, GovDelivery would allow the FSA to "reach … farmers better" (O'Phelan, 2014). GovDelivery notifications are now sent to each farm's owner and operator, as identified in USDA FSA records. Additional relevant parties, such as an individual with power of attorney, or a professional farm manager whose services are engaged by the farm owner, may also request to receive GovDelivery notifications (B. Powelson, email message to author, December 21, 2018).

Unrelated to issues of farmer communication, in the summer of 2016, I began working with the Illinois Farm Service Agency to identify the needs and challenges of the state's "underserved farmer" population. The USDA definition of underserved farmers includes beginning farmers and ranchers (those who are new to farming or who have operated a farm/ranch for fewer than 10 consecutive years), limited resource farmers (whose farm revenue and household income fall below a certain level), and socially disadvantaged farmers (members of certain racial or ethnic groups such as American Indians, African-Americans, and Hispanics) (USDA NRCS, 2014). While the Census of Agriculture (USDA NASS, 2014) provides statistical information about various demographic groups within the farming population, the county-level Farm Service Agency offices are closely tied to their local farming communities and therefore may be able to provide the "story behind the numbers" that mere census tables and reports do not. Illinois is divided into seven FSA districts, each administered by a district director and comprised of 13 to 20 counties. In more rural areas, one local FSA office may serve more than one county; each office is served by a county executive director and a farm loan manager, with many of these individuals responsible for more than one local office. The district directors organize regular district-wide meetings periodically with staff from the local county offices within their district, and with the endorsement of the state agency office, I was invited to one of these routine district-wide meetings within each of the seven IL FSA districts. Between September 2016 and March 2017, I traveled to seven Illinois locations for these meetings (Greenville, Tuscola, Fairfield, Mt. Carroll, Pekin, Morris, and Coatsburg) in order to hold focus groups with the district director, county executive directors, farm loan managers, and other key personnel from the county offices within each district. I arrived at these meetings prepared to learn about the under-served farming population as it is typically defined. However, an unexpected theme emerged from these open-ended discussions, centered on the ways in which county-level FSA offices are now allowed to communicate with their constituents since the full implementation of GovDelivery. Many focus group participants believed that in the past, printed newsletters and postcards mailed directly from their local offices were a very effective way for them to communicate with their constituent farmers about FSA programs and services. They also shared that since GovDelivery replaced paper mailings, the local offices have little to no autonomy in what they can send. Prohibited from utilizing directly mailed printed materials, some county FSA personnel reported that their offices place three or four phone calls per year to each farmer they serve, which is a labor- and time-intensive way for these offices to communicate and contradictory to the goal of increased efficiency with the adoption of GovDelivery. Several participants suggested that "underserved" farmers may be those who either lack reliable Internet service, or who are simply not willing or able to fully utilize email as a primary means of receiving information, with one individual stating that elderly landowners who do not use the Internet are "disenfranchised" by the replacement of paper mailings with the GovDelivery system. Other comments from focus group participants included:

> *"Farmers need more than 'here is a link to a resource' when they are learning about FSA programs."*

> *"Our hands are tied on what type of communication can go out from our [local] office."*

> *"We like how it used to be … when we could send something [farmers] could put on their refrigerator."*

> *"Farmers give more credence [to information] if it comes from the county office."*

> *"What about those [farmers] without Internet?"*

## SURVEYING ILLINOIS FARM SERVICE AGENCY COUNTY-LEVEL PERSONNEL

At the outset of this project, I planned to write a survey directed to FSA staff specifically addressing their perception of the needs and challenges of traditionally underserved farmers, based on what I learned about those farmers from the focus groups I was conducting with FSA personnel. However, given the communication concerns that emerged from the focus groups, I instead designed a 15-item survey following the "Tailored Design Method" (Dillman, Smyth, and Christian, 2014), targeted to FSA staff, that included several questions specifically addressing the ways in which local FSA offices communicate with and serve the farmers in their counties.

The survey was mailed to 104 FSA county office staffers throughout the state (including each of the District Directors, County Executive Directors, and Farm Loan Managers) using a mailing list compiled from public directory information available from the IL FSA website (IL FSA, 2017). The initial survey mailing was sent in July 2017, generating 59 responses; those who did not complete the first survey received a follow-up mailing approximately one month later, and the second survey generated 17 additional responses for a total of 76 participants (a 73 percent response rate).

## CHARACTERISTICS OF SURVEY RESPONDENTS

The majority (75 percent) of survey respondents serve as County Executive Directors; 11 percent are Farm Loan Managers, 8 percent are District Directors, and 8 percent indicated other titles including Senior Farm Loan Officer and Key Program Technician (because some participants serve in multiple roles, these percentages add up to over 100 percent). Slightly under half of respondents have been employed by the FSA for 30 years or more, and half of respondents are responsible for two or more county offices in their roles with the FSA.

## PERCEIVED EFFECTIVENESS OF FSA COMMUNICATION WITH FARMERS

Of the 75 respondents who indicated an opinion about the ways they are allowed to contact their constituents, 52 percent believe that the current communication methods they use do not enable them to effectively serve farmers' needs by providing important and timely information in a manner that is consistent with how they believe their constituents prefer to access that information. While respondents' age was not measured in the survey, years of service to the Farm Service Agency was used as a proxy for age in order to examine the potential relationship between respondents' age and their perception of GovDelivery's effectiveness as the agency's primary communication tool. A chi-square test of independence was calculated comparing the perceived effectiveness of current communication methods based on years of service to the agency. There was no significant relationship ($\chi^2(5)=6.572$, $p>0.05$), suggesting that perception of GovDelivery's effectiveness is independent of the respondent's age.

Survey participants were asked to rank five communication methods (discussed by focus group participants) in order from what they perceive as the most effective to what they perceive as the least effective in reaching the farmers served by their offices (1=most effective; 5=least effective). Table 1 shows the percent of respondents identifying each method as the most effective, along with the average ranking for each of the five methods. Mailing printed materials was identified as the most effective method for communicating with local farmers (average ranking of 1.58/5 and selected as the most effective method by two-thirds of respondents). This was consistent with the opinion that "postcards are very effective," expressed by multiple focus groups. Just 1 percent of respondents selected email as the most effective way to communicate with local farmers, with an average ranking of 3.37/5. Seventy-three respondents provided insight on the local availability of Internet access, with 40 percent indicating that reliable Internet service is not widely available in the rural areas of the counties they serve. Seventy respondents answered a question about the "open rate" for FSA emails. Incredibly, 74 percent indicated that the farmers in their counties open 25 percent or fewer of the FSA email messages they receive. As shown in Table 2, a chi-square test of independence was calculated comparing the open rate for FSA emails based on the reliability of Internet access in rural areas. No significant relationship was found ($\chi^2(3)=1.379$, $p>0.05$), suggesting that the rate at which farmers open FSA emails is independent from their access to reliable Internet service. However, current communication methods used by the FSA were more likely to be perceived as effective in counties with reliable rural Internet access (73.5 percent) than in counties without reliable rural Internet access (47.4 percent) ($\chi^2(1)=5.105^*$, $p<0.05$) (Table 2), suggesting that local FSA personnel believe there is a relationship between Internet reliability and the effectiveness of email communication with the farmers they serve.

## PUTTING THESE RESULTS INTO CONTEXT: FARMERS' USE OF COMMUNICATION TECHNOLOGY

Results from the biennial *Farm Computer Usage and Ownership* report presented in Table 3 show that in 2017, 79 percent of Illinois farms and 73 percent of U.S. farms reported they had access to computers (USDA NASS, 2017). This is fairly consistent with the 77.4 percent of households in the general population that reported having a laptop or desktop computer in the *2016 American Community Survey* (U.S. Census Bureau, 2017). The *Farm Computer Usage and Ownership* report (USDA NASS, 2017) also reveals that 78 percent of Illinois farms and 71 percent of U.S. farms had Internet access in 2017 (compared to 81.9 percent of general population households according to the *2016 American Community Survey*) (U.S. Census Bureau, 2017). Within this context, on the surface, it appears that online communication with farmers, such as the GovDelivery email system adopted by the USDA FSA, may be an effective tool for the agency to stay connected with its constituents. However, Table 3 also tells another side of this story, revealing farmers' relatively low use of online communication technology such as computers, smartphones, or tablets, to conduct farm business. In 2017, 59 percent of Illinois farms and 47 percent of U.S. farms reported they had used a computer to conduct farm business, with 53 percent of

Illinois farms and 39 percent of U.S. farms conducting farm business via smartphone or tablet (a question addressing the use of smartphones and tablets was added to the biennial *Farm Computer Usage and Ownership* report in 2017, and therefore data on those technologies are not available from previous years) (USDA NASS, 2017). Table 4 presents results from the *Farm Computer Usage and Ownership* report relating to farms' use of the Internet to access USDA reports or connect with USDA services. Adoption of online technology is even lower in this context, with 24 percent of Illinois farms and 18 percent of U.S. farms accessing USDA reports or services over the Internet (USDA NASS, 2017).

According to the Federal Communications Commission's *2018 Broadband Progress Report*, 69.3 percent of the rural population nationwide had access to high-speed broadband in 2016 (defined as download speeds of 25 mbps or higher), compared to 92.3 percent of the total U.S. population (FCC, 2018). This "rural/urban digital divide" (CoBank, 2015) is well known, and the FCC is taking steps to address it. In August 2018, $100 million in FCC funding was announced for the purpose of expanding high-speed broadband to rural Illinois over a 10-year period (Illinois Public Media, 2018). Table 5 presents the accessibility of high-speed broadband access across the seven FSA districts in Illinois, showing that while the distribution of farms across the districts is fairly even, the availability of high-speed Internet among the districts is not. As of December 21, 2018, Broadband Now's website shows that 56 Illinois counties (54.9 percent of all counties in the state) have high-speed broadband coverage for at least 69.3 percent of their populations (which is the national coverage rate for the rural population); just 16 counties (15.7 percent of the state's counties) have high-speed coverage for 92.3 percent or more of their populations (the national coverage rate for total population). These Illinois figures are reported for entire counties, not just rural areas, implying a lower coverage level for the rural farming population. While rural areas wait for high-speed Internet service, smartphones are another potential tool that farmers may use to access the Internet and their email accounts, thereby circumventing unreliable Internet service. However, just 16 percent of Illinois farms utilize mobile technology as their primary method of Internet access (USDA NASS, 2017), suggesting that smartphones may not be used as a substitute for reliable high-speed Internet. When viewed within this context, the perspectives expressed by the Illinois Farm Service Agency personnel are perhaps not too surprising.

## IMPLICATIONS

The USDA Farm Service Agency replaced paper communication with GovDelivery in order to save both time and money. While the readership rate for printed FSA mail prior to the adoption of GovDelivery is not currently known, the extremely low open rates for agency emails suggests that timely deployment of information to FSA constituents such as farm owners, farm operators, and their representatives may not be efficiently accomplished by relying solely on electronic means. With nearly 31 percent of rural America lacking broadband capability (FCC, 2018), and 29 percent of farms nationwide without Internet service (USDA NASS, 2017), concerns about Internet access are not unique to one state. In the immediate short run, effective outreach will be crucial as the USDA educates its constituents about changes contained in the 2018 Farm Bill. Beyond that, in light of what the USDA itself has measured with its *Farm Computer Usage and Ownership* report (USDA NASS, 2017) and the perspectives of front-line FSA personnel, relying on GovDelivery may not be the most effective method for keeping farmers informed about FSA programs and services, eligibility requirements, sign-up or filing deadlines, and countless other details. While the findings from this case study suggest that it may be worth reconsidering the FSA's policies on farmer communication, a future expansion of this research will address the readership rate for the printed mail that the FSA sent to its constituents prior to the adoption of GovDelivery communication, and explore how farm owners, operators, and managers prefer to receive USDA FSA notifications. In the meantime, it appears that farm owners, operators, and managers should be encouraged to engage more readily with electronic communication from the agency.

## REFERENCES


Broadband Now. n.d. "Broadband Internet in Illinois." Accessed December 21, 2018. https://broadbandnow.com/Illinois

CoBank. 2015. *Bridging the Rural/Urban Digital Divide*. https://www.cobank.com/-/media/files/ked/communications/bridging-the-rural-urban-digital-divide---june-2015.pdf

Dillman, D.A., J.D. Smyth, and L.M. Christian. 2014. *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. 4th ed. Hoboken, NJ: John Wiley & Sons.

O'Phelan, M. 2014. *How USDA Farm Service Agency Saved Millions and Reached More Stakeholders*. https://granicus.com/blog/how-usda-farm-service-agency-saved-millions-of-dollars-and-reached-a-critical-number-of-stakeholders-digitally/

U.S. Census Bureau. *2016 American Community Survey 1-Year Estimates: Types of Computers and Internet Subscriptions*. Retrieved June 27, 2018, from American Fact Finder: https://factfinder.census.gov.

U.S. Department of Agriculture — Farm Service Agency Illinois FSA Office (IL FSA). 2012. *Newsletter*, May. https://www.fsa.usda.gov/Internet/FSA_File/stonmay2012.pdf

U.S. Department of Agriculture — Farm Service Agency, Illinois FSA Office (IL FSA). 2017. *Service Center Locator*. https://offices.sc.egov.usda.gov/locator/app?state=il&agency=fsa

U.S. Department of Agriculture — National Agricultural Statistics Service (USDA NASS). 2017. *Farm Computer Usage and Ownership*. http://usda.mannlib.cornell.edu/usda/current/FarmComp/FarmComp-08-18-2017_correction.pdf

U.S. Department of Agriculture — National Agricultural Statistics Service (USDA NASS). 2014. 2012 *Census of Agriculture*. https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf

U.S. Department of Agriculture — Natural Resources Conservation Service (USDA NRCS). 2014. *Small & Limited and Beginning Farmers and Ranchers*. http://nrcs.usda.gov/wps/portal/nrcs/main/national/people/outreach/slbfr/

U.S. Federal Communications Commission (FCC). 2018. *2018 Broadband Deployment Report*. https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report

**Table 1. Perceived effectiveness of communication methods as reported by county FSA officials**

| Communication Method (n=73) | % of respondents selecting as most effective method | Average Ranking |
|---|---|---|
| Printed mailing (newsletter or postcard) | 66% | 1.58 |
| Phone call | 29% | 2.63 |
| Notice on local radio station | 3% | 3.94 |
| Email | 1% | 3.37 |
| Notice in local newspaper | 1% | 3.41 |

Note: Rankings were on a scale of 1=most effective to 5=least effective.

**Table 2. Relationship between rural Internet access, email open rates, and communication effectiveness**

| | Reliable Internet available in rural areas | |
|---|---|---|
| | Yes | No |
| | % | |
| Open rate for FSA emails† | | |
| 25% or less | 60.80% | 39.20% |
| 26–50% | 50.00% | 50.00% |
| 51–75% | 77.80% | 22.20% |
| More than 75% | 66.70% | 33.30% |
| Current communication methods perceived as effective†† | | |
| Yes | 73.50% | 26.50% |
| No | 47.40% | 52.60% |

†$\chi^2(3)=1.379$ (NS)
†† $\chi^2(1)=5.105^*$ ($p<0.05$)

| Table 3. Farm access to and use of communication technology[a] | | | | | | |
|---|---|---|---|---|---|---|
| | Illinois | | | United States[b] | | |
| | 2017 | 2015 | 2013 | 2017 | 2015 | 2013 |
| Farms with access to a computer | 79% | 79% | 71% | 73% | 73% | 70% |
| Farms with Internet access | 78% | 72% | 70% | 71% | 70% | 67% |
| Farms conducting farm business via computer | 59% | 55% | 53% | 47% | 43% | 40% |
| Farms conducting farm business via smartphone or tablet | 53% | NA | NA | 39% | NA | NA |

a. Data from USDA NASS *Farm Computer Usage and Ownership*, August 2017.
b. Does not include Alaska and Hawaii.

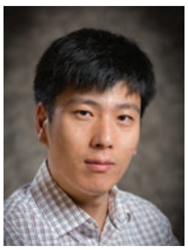
| Table 4. Farm use of Internet to connect with USDA resources[a] | | | | | | |
|---|---|---|---|---|---|---|
| | Illinois | | | United States[b] | | |
| | 2017 | 2015 | 2013 | 2017 | 2015 | 2013 |
| Farms using Internet to retrieve USDA NASS reports | 15% | 14% | 13% | 11% | 10% | 8% |
| Farms using Internet to access USDA services or non-NASS reports | 24% | 22% | 21% | 18% | 17% | 14% |
| Farms using Internet to “conduct business with any USDA website” | 14% | 14% | 8% | 10% | 9% | 6% |

a. Data from USDA NASS Farm Computer Usage and Ownership, August 2017.
b. Does not include Alaska and Hawaii.

| Table 5. Broadband access across the seven Farm Service Agency districts in Illinois | | |
|---|---|---|
| FSA District | % of total Illinois farms within district | Average % of district counties' population covered by high-speed broadband |
| 1 | 13.45% | 55.96% |
| 2 | 15.68% | 68.24% |
| 3 | 14.47% | 65.03% |
| 4 | 14.47% | 81.70% |
| 5 | 12.37% | 56.05% |
| 6 | 14.45% | 86.85% |
| 7 | 15.11% | 75.44% |

a. Data from USDA NASS 2012 Census of Agriculture.
b. Data from Broadband Now.

# Entrepreneurs and Start-ups in the Agricultural Industry



**By Marta Grant and Wendong Zhang**

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## Abstract

*Analyzing 24 recent agricultural start-up companies and 23 agricultural applications, this article provides an overview of entrepreneurs and start-ups in the agricultural industry, with a focus on crop production and farm management. Agricultural entrepreneurship is gaining traction and getting more support from universities and industries. While most recent agricultural start-ups focus on producers, opportunities exist to better serve investors and agricultural professionals. Better data management to assist agricultural production and management decisions would be a potential source of new ideas. Despite the challenges, the rural property professionals should be more aware of newer data, tools, and technologies brought by these innovative firms. Additionally, automation, artificial intelligence, and sensors will present significant opportunities for new start-ups.*

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## INTRODUCTION AND METHODOLOGY

Since the late 2000s, there has been a boom in the number of agricultural start-ups and entrepreneurship careers. Hundreds of new services are available for producers and agricultural professionals to take advantage of, but learning about all of these new companies can be confusing. The goal of this article is to identify some of the newer agricultural technologies and services available by focusing on new start-ups relevant to crop farmers, landowners, investors, and agricultural professionals. Big data, drones, sensors, and satellite imagery have changed how crop farmers produce and market their grain and it is important to analyze the various types of services and customers that these technologies affect.

Several articles about new agricultural technologies within the agricultural media exist; however, few analyze the entrepreneurship side of the technologies. For example, Successful Farming wrote several articles about new agricultural companies and compiled a "top 10" list of apps for agriculture (Walter, 2016). CropLife and The Verge note that new technologies are available to agriculturalists and that ag start-ups can be found anywhere in the United States, from California's Silicon Valley to small Midwest towns (Hopkins, 2017; Potter, 2016). Kevin Kimle of Iowa State University has written articles about agricultural technologies and entrepreneurships and provided congressional testimony on the subject (Kimle, 2018). Recently, researchers and professionals are increasingly cognizant of the implications of big data and artificial intelligence for rural property professionals (Linne, 2017, 2018; Griffin et al., 2016).

The purpose of our article is to analyze agricultural start-ups and entrepreneurship and offer a summary of new technologies and services available for farmers, landowners, and agricultural professionals. In this article, we identify start-ups as businesses less than 10 years old that develop their own technologies/apps. In particular, we analyze types of targeted customers, services offered, prices, years founded, and types of mobile apps being created. We include three interviews with separate entrepreneurs about their lifestyle, accomplishments, companies, and perspectives on agricultural entrepreneurship. We analyze 24 companies and 23 mobile apps from "top 10" lists from leading agricultural media previously mentioned. This is not an all-inclusive list of agricultural start-ups, and we omit start-up companies designed for livestock producers and investors and those that focus on the food industry as opposed to agricultural production and farm management.

Agricultural start-ups focus on several types of customers, but most recent start-ups focus on helping producers improve efficiency and management. Of the apps we analyzed, the majority analyze soil, crop, and nutrient data. Many of these apps and companies don't create new information. Instead, they rely on public information from United States Department of Agriculture (USDA) or National Oceanic and Atmospheric Administration (NOAA), as well as private data submitted by users, to provide new platforms to better visualize, understand, and incorporate data into production and business decisions.

There are four main takeaways from our article. First, entrepreneurship is a career that is gaining interest, especially with Kickstarter campaigns and grants available. Second, most current start-ups focus on producers, thus there are not many services available for brokers, investors, businesses, or retailers. Third, better data management is an easy way to improve any operation. Businesses can become more efficient through better management of inputs, fertilizer applications, equipment, marketing, and analysis of data from nutrient samples, equipment logs, and land sales. Fourth, the experts and entrepreneurs interviewed in this article agree that automation, artificial intelligence, and sensors will present significant opportunities for new start-ups.

### Results: Trends in and Determinants of Ag Start-ups and Entrepreneurs

This section provides a general overview, trend statistics, and determinants of agricultural start-ups and entrepreneurs.

## WHO ARE THE ENTREPRENEURS?

**Occupation:** Entrepreneurs work at their business all of the time. Hard work and long hours are a consistent theme among all entrepreneurs, as they are responsible for all aspects of their company. However, all entrepreneurs have passion for what they do.

**Funding Source:** Most new businesses, (within the last 10 years) were funded through a Kickstarter campaign and still receive funding from investors. Kickstarter campaigns offer financial support to fund new businesses or projects, and many universities have Kickstarter campaigns to help students start their own businesses. There are several privately funded Kickstarter campaigns, such as Ag Start-up Engine and AgriTech Accelerator in Iowa. After 10 years, most businesses are financially independent with stockholders or holding companies.

## WHEN WERE THE START-UPS FOUNDED?

It is crucial to examine when the start-ups were founded, as an increase in new business ideas can signal a stable and growing economy. Figure 1 shows the number of start-ups in our analysis based on how many were founded that year. Before the 2007–2008 financial crisis, only a few companies explored the possibility of virtual reality and satellite imagery in their agronomic decisions. This was most likely because of a lack of funding and the recession. A significant uptick occurred in the early 2010s when the big data movement created a need for new technologies. For example, drones generate constant data and create a significant need for better data management. Several new businesses filled this niche with products to better manage, organize, understand, and utilize data and new platforms, such as cloud storage, to improve production efficiency or profitability.

## PURPOSE OF THE WEBSITES AND APPS

We aggregate website and app services into several categories based on their purpose, which we determine from the main goals and services offered by the company or app. Figures 4 and 5 divide the start-ups and apps into several categories including yield estimation, land valuation, yield data management, crop/soil health, farm data management, commodities/markets, advising, ag news, and machinery sales.

Most services offered by ag businesses focus on farm data management, field data management, and land valuation; and, most are used to compile data and analyze production efficiencies, productivity, and profit management. This is in stark contrast to mobile agriculture apps, the majority of which focus on monitoring crop and soil health and soil levels and nutrient management. Most apps focus on crop and soil health because users have mobile devices with them in the fields and are able to track data and information on site. Most users do not analyze financial profits while crop scouting and would not be using Granular or other accounting programs on their mobile devices. Apps are developed to assist producers with day-to-day activities on the farm, putting professional consultation, market analysis, and nutrient information at their fingertips. Apps make information easily accessible and useful during real-time farming.

In the following section, we discuss services companies offer that best correlate to the purposes listed above — yield estimation, land valuation, yield data management, crop/soil health, farm data management, commodities/markets, advising, ag news, and machinery sales. Although this list is not exhaustive, it features several companies that are changing the way people do business in agriculture and improving productivity, efficiency, and sustainability. Apps provide previously unavailable accessibility to rural agriculturalists that allows them to improve their businesses.

**Yield Estimator:** Descartes Labs, available through both mobile app and website, is a very accurate source using satellite imagery for predicting crop yields. Descartes Labs releases new yield predictions every two days based on satellite images of crops and weather predictions. Descartes Labs evaluates the health of crops based on satellite images and imputes the predicted yield of the crop at the national, state, and county levels (Brokaw, 2016).

**Land Value:** FarmlandFinder, a land valuation and sale company, collects all land value and investment information in one place. FarmlandFinder has farmland sale information, soil survey data, crop history, and many other services available for people looking to invest in land. Users can also list farmland for sale and contact real estate professionals through the website. Users with free accounts can view land for sale and various associated data; and, paid subscribers can view past land sales, see auction reports, and access sales databases.

AcreValue is a nationwide website that features predicted parcel-level land value, field characteristics, and water rights. With a free account, users can view information about a land parcel including the name of the landowner.

Accuacre is similar to FarmlandFinder, allowing users to view the number of acres and estimated price per acre, but is currently only available in Indiana. Accuacre was developed by Peak Soil Index and gives users prices based on the whole state, district, county, or specific parcel of land, along with crop yield, soil type, and soil quality.

**Field Data Management:** OnFarm Systems combines data from several sources and equipment into an easy-to-use application. OnFarm Systems collects soil moisture and weather data and organizes it according to agronomics, weather, and mapping so that it can be used productively.

**Monitor Crop/Soil Health:** Encirca, developed by DuPont Pioneer, helps growers with managing soils, weather data, and crop scouting. Climate Fieldview, developed by Climate Corporation, monitors productivity, performs analysis, organizes data from various platforms, and offers unique features to track weather patterns and monitor rainfall in individual fields.

**Farm Data Management:** Farm data management applications analyze finances, inputs, agronomics, and combinations of such. Granular is a business software that helps improve profitability and efficiency, tracks inputs and inventory, forecasts and analyzes profits, measures yield variability, offers crop and field planning, integrates data from other sources, and offers succession planning assistance for any operation.

MMP360, developed by EFC Systems, is a unique program for livestock producers, which is used in Iowa to help with manure application rates and completing Department of Natural Resources required paperwork. MMP360 maps manure application, calculates the phosphorus index for individual fields, and compiles data into documents that can be referenced for an audit or MMP records.

**Commodity Trader/Market Information:** Several companies offer mobile apps for trading commodities from anywhere. Mercaris offers information about organic and non-GMO commodities. Users can analyze price differences between food and feed-grade products, organic and conventional prices, regional basis prices, and cash and forward market prices and can buy and sell contracts directly through Mercaris.

**Advising:** Agrisync connects farmers and advisors anytime and anywhere. Farmers are able to connect with mechanics, brokers, financial advisors, and agronomists through face-to-face video, which helps efficiency and productivity when solving day-to-day problems and answering questions.

**Ag News:** AgWeb, Ag Mobile, and Farm Futures offer mobile apps so users can keep up on agricultural news, which is crucial for people on the go who no longer get their news from print sources such as magazines and newspapers. These apps offer market updates, weather forecasts, trading, and economic news, as well as radio shows and podcasts.

**Machinery Sales:** Tractor House advertises new and used farm equipment for sale. Tractor House uses an app and a website to market equipment and parts and also lists elevators, coops, dealers, and auctions. There is also a want-to-buy section where people can search for the equipment they are looking to buy.

## INTENDED CLIENTS AND KEY SERVICES

Understanding the intended clients of businesses helps determine target audiences and the services entrepreneurs should provide. In this article, we divided intended clients into five categories: producers, businesses, retailers, investors, and brokers.

Figure 2 shows that over half of ag start-ups we analyzed were created with producers as their intended user, and Figure 3 shows that a majority of the apps analyzed in this paper were also geared toward producers.

We analyze intended clients for each business and the key services offered by businesses to each type of customer. Key services offered to producers include yield and weather predictions, land valuation, monitoring chemical applications, tracking operations and financials, field mapping, variable rate seeding, soil analysis, crop health imagery, and data management. Key services available for retailers, specifically seed or feed dealers and agricultural sales personnel, include tracking inventory, measuring field data, and overall data management. Key services for brokers include analyzing commodity market data and trading agricultural commodities. Key services for investors include yield estimation, land valuation, management scenarios, commodity market analysis, and agricultural consulting, as wells as organic and niche markets. Key services for businesses include market updates, ag news, machinery sales, yield estimation, and analyzing global agricultural data. Few apps are available for businesses, retailers, brokers, and investors, but most offer news, market information, and data management.

Start-ups and apps can be useful to multiple firms and are therefore included in each category; thus, the data in each graph does not add up to the 24 start-ups and 23 apps we cover in our article.

## PLATFORMS

All start-ups we evaluate in this article have a website but not all have an app. All apps we researched support iOS and Android systems, which is essential as it ensures broad and fair access by users. Most apps offer new sources or data-recording features such as market updates, weather forecasts, soil sampling, field maps, weed and disease identifications, yield calculators, inventory changes, photos of crops/weeds/diseases, and chemical mixing. Companies that don't have mobile apps offer their services through a variety of platforms, thus they are able to reach more customers and expand their business opportunities.

## FEES AND COSTS

All mobile apps we examined have free services, such as previews of their software and programs, but most offer more in-depth services or full access for a fee.

Pricing for the products we investigated fall into three categories: program purchase, subscription, and per acre. Program purchase includes software and technology for a fixed price schedule. Subscription includes free products that can be upgraded for a fee to gain more access and services. Per acre pricing includes products with a cost based on the number of acres analyzed or serviced. One company, SoilWeb, is a free online service created by the UC Davis California Soil Resource Lab.

Figure 6 shows the annual cost to upgrade to the first level of paid access ranges from approximately $100 to $1,000 for each company that offers subscription pricing. This range covers the first upgrade available, not necessarily the most expensive. If yearlong plans are not available, we multiplied monthly cost by 12 to determine yearly costs. This is computed on a monthly billed basis.

## SPATIAL COVERAGE

Most companies we analyzed offer services for the continental United States or focus on the Midwest only. Coverage is often dependent on company age — more established start-ups from the early 2010s often have greater coverage than recently established companies.

## DATA SOURCES

Many companies use data from USDA and other public databases to show information in easily understandable and interactive platforms. USDA soil maps and NOAA satellite imagery are free sources of information that anyone can access, but companies can create platforms that put public and private data in one place to be analyzed. Very few companies have created new technology to track data — many used free public data that already existed and private data submitted by producers/businesses/investors.

## IN-DEPTH INTERVIEWS WITH EXPERTS

### Researcher/Entrepreneur: Kevin Kimle, Rastetter Chair of Agricultural Entrepreneurship and Director of the Agricultural Entrepreneurship Initiative at Iowa State University

This interview was conducted May 4, 2018, to gauge Kevin Kimle's perspectives on the future of agricultural technology, entrepreneurship, and the role of Kickstarter programs. Kimle founded and co-founded several businesses and created the Agricultural Entrepreneurship Initiative at ISU. Students involved in the Agricultural Entrepreneurship Initiative and its classes turn out more than 100 start-up business plans each year, many in the agricultural technology space. Businesses incubated with his direct involvement include ScoutPro, AccuGrain, Agricutlure Concepts, SmartAg, Performance Livestock Analytics, Gross-Wen Technologies, and Terva (Ag Start-Up Engine 2018).

When looking at a potential business plan, Kimle always assesses the entrepreneur's skill set. Kimle never knows whether an idea will be viable or successful, but the mindset and skills of the entrepreneur are very important when managing a new company. The skill set of a successful entrepreneur includes adaptability in challenging situations, effective team building, effective persuasion, and a willingness to explore new ideas. Kimle suggests that entrepreneurs also have empathy skills — entrepreneurs should be able to hear other people's perspectives and "see what they are thinking," then turn those ideas into a product or business and persuade others to buy in. They also need to question themselves and evaluate whether a market exists for their product.

It usually takes five years for a business to be "on its feet" and 10 years to profit. Kimle shared a graph (see Figure 7) that describes how he looks at a potential product in the market, which illustrates that a new idea could be very beneficial as well as risky, but older technologies and ideas may not be profitable. When a new product is created, it can be placed in any quadrant on the graph. The bottom left quadrant includes ideas that already have markets and products. The upper right quadrant includes new ideas for which there is not a market for the product. The upper left and bottom right quadrants are combinations of either an existing market and new technology or a new market and existing technology. Products further into the upper right quadrant have more risk, but also possibly greater reward.

Kimle has noticed a trend that people completely outside of agriculture are taking interest in agricultural companies. These people are able to look at agricultural problems and create unique solutions because they have little-to-no experience in agriculture.

Iowa lacks investment companies that support start-ups. There are few accelerators or incubators in agriculture because most investment money is located in Silicon Valley or New York City. The Midwest is underdeveloped for high risk and high reward investment companies; thus, these companies are more likely to form elsewhere. However, places such as Kansas City, Chicago, the Twin Cities, and Des Moines are attractive places to live and are becoming great environments for new business start-ups.

Kimle says he sees the future of agricultural technology heading toward more automation technologies. For example, artificial intelligence technologies and data sensors can be used to track all sorts of measurements and make agricultural businesses more efficient.

### Start-up Entrepreneur: Steven Brockshus, founder and CEO of Terva LLC, a technology company founded in 2016 that develops products and services to make farmland information accessible. The flagship product is FarmlandFinder.

This interview with Steven Brockshus was held May 14, 2018, mainly to discuss his experience transitioning from an undergraduate student to business owner of Terva. As the founder and CEO, Brockshus leads the Terva team — setting the vision, building the brand, and growing relations with customers and stakeholders.

The path leading up to this was not an easy one and involved lots of thoughts and research. While attending Iowa State University, Brockshus took two years off school and traveled as a National FFA Officer, during which time he met several entrepreneurs. He admired their lifestyle, perspective of the world, and their passion for their job. This led him to add a minor in entrepreneurship and join the Agriculture Entrepreneurship Initiative when he returned to Iowa State. Additionally, he participated in Cy Starters at Iowa State and Venture School with the University of Iowa. These programs helped him fine-tune his entrepreneurial skills; and, eventually, Terva was incubated in the Iowa State Agricultural Entrepreneurship Initiative.

The idea for Terva came from several small things. Several years ago, Brockshus went with his father to a land auction in northwest Iowa and started asking questions about the quality of the land, who had owned it, and what previous crops had been grown there. His dad suggested he talk to the broker, which led Steven to the realization that "most of the people in the room knew nothing about the land they were about to spend $1.5 million on." He decided to talk to brokers, bankers, and farmers about land auctions and what information was available to them, which is when he realized there was a need for a system to accumulate data about farmland. There were a few early adopters of his idea, and one brokerage firm sent him a check before his program was even developed. Terva combines data from several sources and makes it easily accessible.

FarmlandFinder is supported by the Ag Start-up Engine in Ames, Iowa. Most of FarmlandFinder's customers are land investors, appraisers, and people looking for information on land value. Farmers are not a large percentage of the client base but are utilizing FarmlandFinder's information through their bankers and brokers. The main marketing strategy of FarmlandFinder is to provide valuable information to professionals, who in the long run assist farmers. They are analyzing how the residential and real estate online platforms have developed and are "putting an ag industry twist on it."

Brockshus believes that entrepreneurship is growing in central Iowa through educational and financial support — programs are being created to support business start-ups and several universities offer entrepreneurship studies in their curriculum. He says the entrepreneurship lifestyle is not for everyone because of the responsibility of running your own business. However, the perks of being an entrepreneur involve designing your own job, work hours, and travel plans.

Brockshus believes that agricultural automation, blockchain, artificial intelligence, and satellite imagery have potential for opportunity. Currently, there is a lot of interest in artificial intelligence and machine learning within agriculture, as well as blockchain, which would offer complete traceability of a product from the farm to the public. Additionally, Steven believes that any sector that has a lack of data would be a good place to look for a new business.

### Established Entrepreneur/Investor: Steve Bruere, President of People's Company, which is the host of the famous Land Investment Expo and also one of the six investors of the newly founded Iowa AgriTech Accelerator

This interview was conducted June 12, 2018, and details how Steve Bruere started his company, expanded his business, and became an investor. In addition, it covers how People's Company incorporates new technologies into its business.

Growing up, Bruere always knew that he wanted to be an entrepreneur; he simply needed to find a way to combine his passions for real estate and agriculture. Immediately after graduating from the University of Northern Iowa, opportunity came knocking. At age 22, he took over a small agricultural real estate company. Fifteen years ago, People's Company was an office with one computer and four pieces of land for sale, now it offers agricultural land brokerage, land appraisal, management, and investment services in 20 states. Bruere credits his supportive family and young start for the success of the business. Because he was young when he took over the company, he was willing to take on challenges and put in the extra hours to make the company successful. After 15 years, the company is still expanding, and each day there are new challenges to be faced.

People's Company utilized new technology to expand. Fifteen years ago, they did not have a website, but now they use drones and software to better manage land and assist customers. People's Company developed its own farm management software to help farmers and landowners be more efficient. They also use AgSolver technology to create profitability maps, FarmlandFinder to find land for sale, and AcreValue to determine the fair value of land. These new technologies have significantly helped the company expand its footprint to other states and other types of farmland.

People's Company also presents the annual Land Investment Expo in Des Moines. In 2008, the conference began as a group of 300 people interested in discussing the future of agricultural real estate and has grown into an annual event that attracts landowners, farmers, policy makers, economists, political leaders, and land investors. Each year they host several keynote speakers to discuss land investment strategies and the farm economy. Attendance has grown to over 700 people annually. Their goal is to help people build connections and learn from investors and professionals from around the world. This event has attracted speakers such as then-businessman Donald Trump and helped Bruere to build a national reputation in the real estate industry.

People's Company is one of the six companies that co-founded the Iowa AgriTech Accelerator in 2016 with the Greater Des Moines Partnership and the Cultivation Corridor. The five other companies include Farmers Mutual Hail Insurance Company, Grinell Mutual, John Deere, Kent Corporation, Dupont Pioneer, and Sukup Manufacturing Co. AgriTech Accelerator is designed to build upon one of the region's key industries — agriculture — and Greater Des Moines' success in advancing start-ups and technology through its many resources available to entrepreneurs. It is part of the Global Accelerator Network, an ecosystem of accelerators whose mission is to work with start-ups toward scalable and sustainable growth. So far, this accelerator has founded five companies, namely Farrpro, Rabbit Tractors, HINTECH AG, WISRAN, and Phenomics Labs.

Bruere believes that interest in entrepreneurship is continuing to grow, and he is constantly learning of new business ideas being developed. Bruere reinforced the idea that owning a business is a lot of responsibility and there is hard work and long hours involved, but if you are pursuing a passion it will be fun. He also mentioned that it is important for entrepreneurs to have a long-term vision and embrace challenges and changes in business plans.

## Concluding Thoughts and Practical Implications

By analyzing two dozen firms' services and entrepreneurial characteristics, we document general trends in agricultural start-ups and entrepreneurship and find a growing number of agricultural companies recently established to improve or revolutionize many sub-sectors within agricultural industries, including yield estimation, land valuation, crop and soil health, management and trading information services. We find that many successful start-ups leverage big data readily available in agriculture and employ newer technologies such as artificial intelligence in analyzing satellite images, collecting and synthesizing public and private datasets in one platform, conducting on-site monitoring and assessment of crop and soil information, and/or providing higher-resolution estimates using techniques such as predictive analytics (Linne, 2018, Griffins et al., 2016). Finally, the experts interviewed agree that automation, artificial intelligence, and sensors could present opportunities for future agricultural start-ups.

Agricultural start-ups have increasingly important practical implications for rural property professionals, presenting both opportunities and challenges. We argue that farm managers, rural appraisers, and agricultural consultants should be more aware of relevant technological developments, even though initial services provided by start-up companies may seem piecemeal and inaccurate. With the aid of big data and artificial intelligence, these new start-ups pose challenges or provide alternatives to some of the services regularly provided by rural property professionals. For example, information about general market trends, physical or agronomical characteristics of the property, and sometimes alternative estimates of crop yields or land values are more readily available for producers. This sometimes presents questions regarding the necessity and value of hiring rural property professionals, and could be subject to misinterpretation and misuse. However, the plethora of new data such as timely and more accurate satellite images have and will continue to enable a more complete understanding of the property and its market and thus aid rural property professionals (Linne. 2017). New data, tools, and technology are increasingly available for agricultural professionals, and the industry should be more aware of, strategically respond to, and take advantage of these newer technologies amid the profusion of data. For example, soil and nutrient sensors could provide more up-to-date measures of true productivity, and newer analytical techniques such as regression analysis and matching could help appraisers better identify suitable comparable sales and value agricultural real estate. In sum, our paper presents a snapshot analysis of the changing face of the agricultural entrepreneurship landscape.

## REFERENCES

Ag Start-Up Engine LLC. 2018. “Current Portfolio.” http://www.agstart-upengine.com/current-portfolio.

Agricharts. 2018. “AgMobile Features.” http://www.agricharts.com/app/.

Brokaw, Alex. 2016. “This Start-up Uses Machine Learning and Satellite Imagery to Predict Crop Yields.” *The Verge*. http://www.theverge.com/2016/8/4/12369494/descartes-artificial-intelligence-crop-predictions-usda.

Griffin, Terry W., Tyler B. Mark, Shannon Ferrell, Todd Janzen, Gregory Ibendahl, Jeff D. Bennett, Jacob L. Maurer, and Aleksan Shanoyan. 2016. “Big Data Considerations for Rural Property Professionals.” *Journal of ASFMRA* 167–180.

Hopkins, Matt. 2017. “17 Agriculture Apps That Will Help You Farm Smarter In 2017.” CropLife. http://www.croplife.com/editorial/17-agriculture-apps-that-will-help-you-farm-smarter-in-2017/.

Kimle, Kevin. 2018. “Building an Ecosystem for Agtech Start-ups: Submitted Testimony U.S. House of Representatives Small Business Subcommittee on Agriculture, Energy, and Trade.” https://smallbusiness.house.gov/uploadedfiles/2-15-18_kimle_testimony.pdf.

Linne, Mark R. 2018. “Artificial Intelligence and the Future of Appraisals: A Tale of Two Teslas.” Presentation at the 2018 ASFMRA Annual Conference.

Linne, Mark R. 2018. “Valuation 2: How to Navigate the Brave New World of Appraisals.” https://www.valuescape.com/articles/Valuation2.pdf.

Potter, Ben. 2016. “Farmers Reveal Top Ag Apps.” *AgWeb*. http://www.agweb.com/article/farmers-reveal-top-ag-apps-ben-potter/.

Texas A&M AgriLife Extension et al. 2018, “Apps for Agriculture.” http://aged.illinois.edu/files/documents/Apps--for--Ag--Revised--AgEd.pdf.

Walter, John. 2016, “Top 10 Ag Apps to Try.” *Successful Farming*. http://www.agriculture.com/technology/crop-management/top-10-ag-apps-to-try.

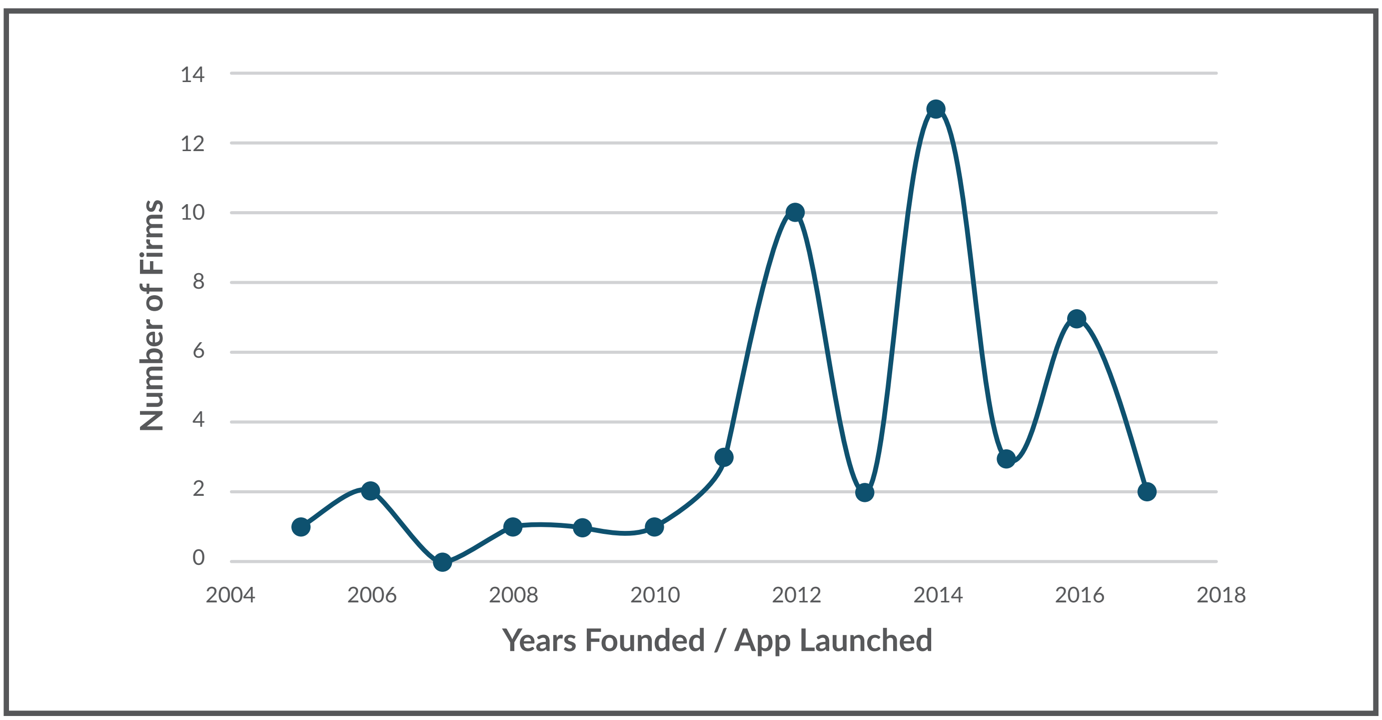


Figure 1

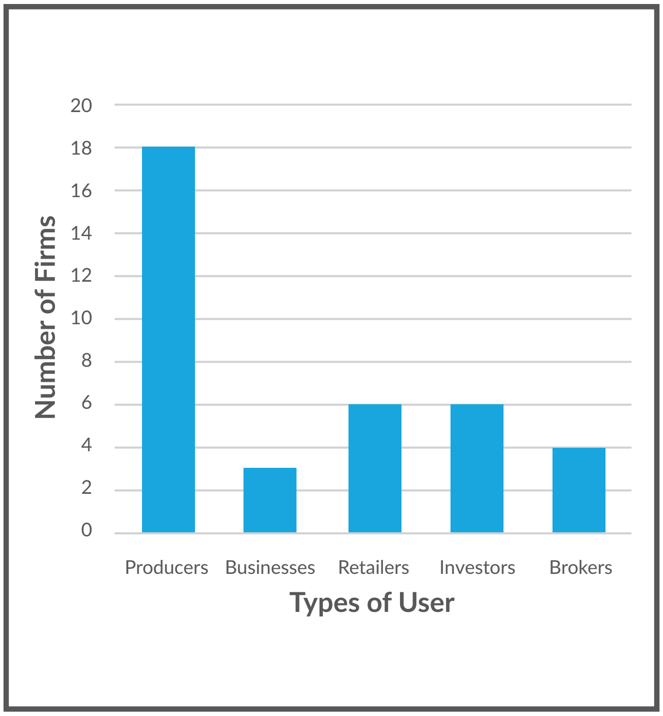


Figure 2

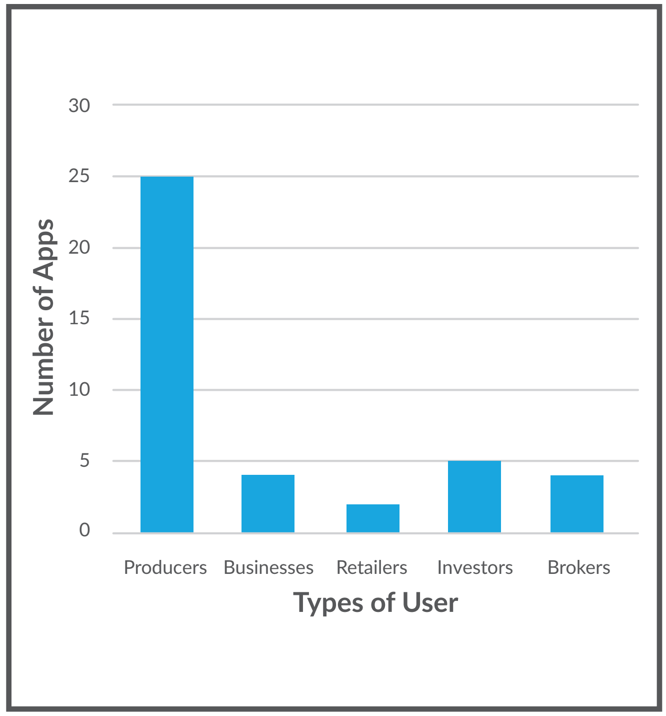


Figure 3

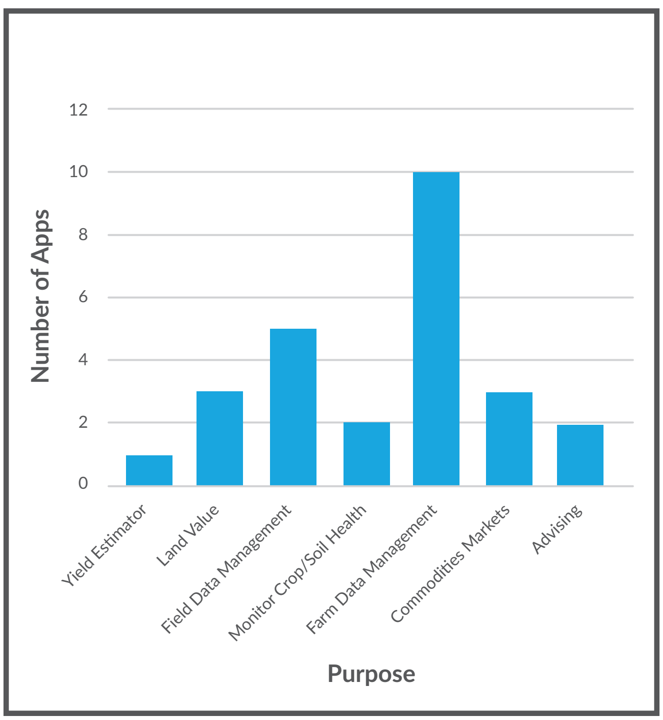


Figure 4

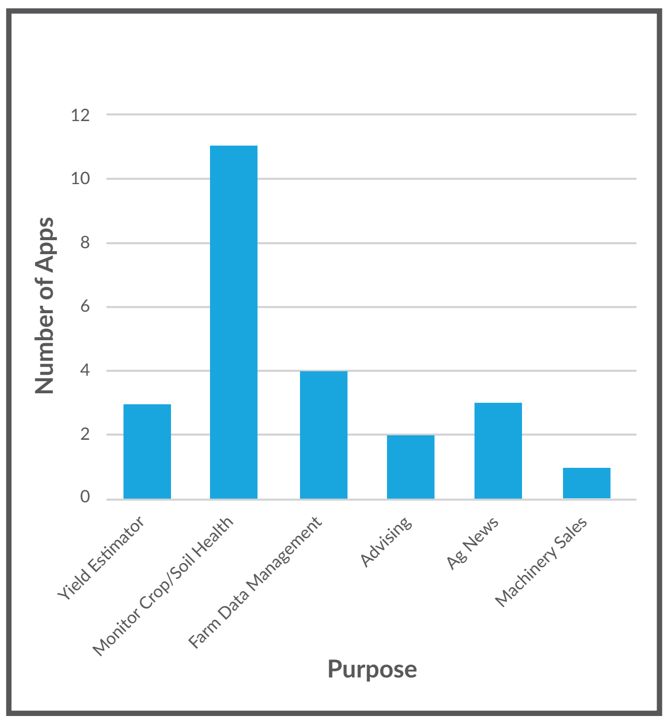


Figure 5

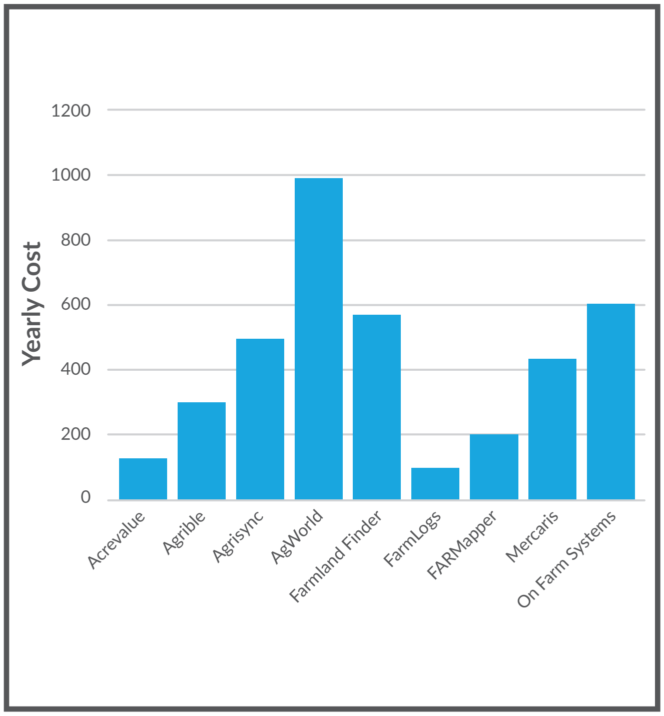


Figure 6

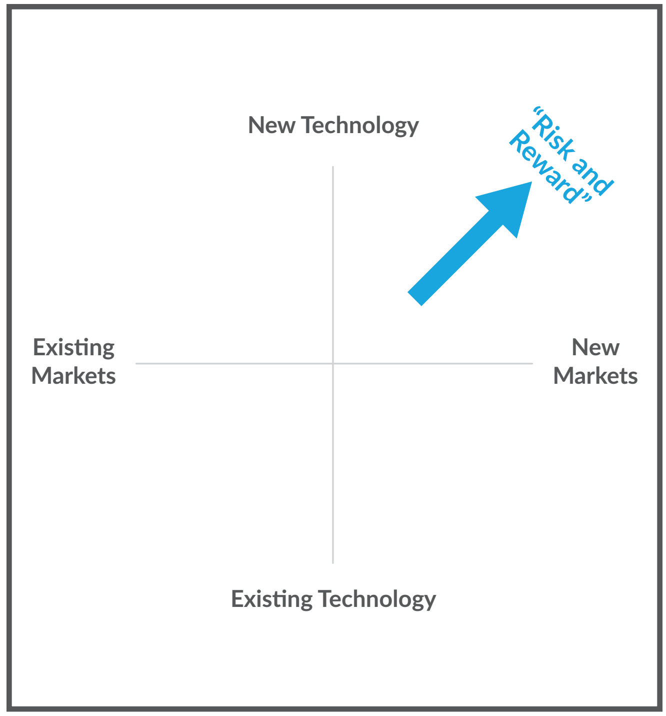


Figure 7

# An Examination of Family Living and Non-Farm Income for Kansas Farms

**By Gregg Ibendahl**

Gregg Ibendahl is Associate Professor in the Department of Agricultural Economics at Kansas State University in Manhattan, Kansas.

## Abstract

*Net farm income has decreased from the record high period of 2007 to 2013 and is currently at a level that is below historical averages. Farms can survive periods of lower net farm income as long as the combination of net farm income and non-farm income is greater than family living expenses. If family living exceeds all income sources, then family net worth is reduced, and the farm family risks bankruptcy if net worth becomes too low. This paper examines the net farm income, non-farm income, and family living for selected Kansas Farm Business Management farms to determine how these farms are weathering the current period of lower net farm income.*

The period from 2007 through 2013 saw grain prices at near historical highs. This resulted in grain farms earning near record net farm incomes for the period (see Figure 1). With net income above historical averages, family spending was not an issue for anyone monitoring farm financial health. As with most families though, farm family living increased in response to the higher level of net farm income. In 2014, grain prices declined enough that many farms are now earning less than they were before the run-up in grain prices in 2007. The last three years especially have seen net farm income at levels below historical averages. Farms can survive periods of lower net farm income as long as the combination of net farm income and non-farm income is greater than family living expenses. If family living exceeds all income sources, then family net worth is reduced and the farm family risks bankruptcy if net worth becomes too low. This paper examines the net farm income (NFI), non-farm income, and family living for selected Kansas Farm Business Management (KFMA) farms to determine how these farms are weathering the current period of lower net farm income. Because non-farm income is such an important source of additional revenue to the farm and is often quite variable among farms, most of the analysis of this paper will focus on an examination of NFI, non-farm income, and family living by three levels of non-farm income.

## BACKGROUND

Detailed farm level data that includes family living is not readily available. Thus, there is not much research on family living outside of Extension publications. The Kansas Farm Management Association (KFMA) does have detailed family living on some farms, and that data is used in this analysis. The KFMA program works with approximately 2,500 farms generating whole farm, enterprise, and family living data. Whole farm data that can produce income statements, balance sheets, and tax returns is the most common data generated. Last year, about 1,500 farms had use-able whole farm data. Less commonly produced are enterprise studies and family living data. In 2017, the KFMA program had approximately 300 farms with useable family living. Family living data for the KFMA program actually goes back to the beginning of the computerized financial records of the program (1973), but the most useable family living data is limited to 1993 through 2017. In 1993, a new certification variable just for family living was introduced that made family living data much more trustworthy. Until then, the completeness of family living data was never certain.

Figures 1 and 2 provide the motivation for examining family living and whether farm families are spending within their means. Figure 1 shows the average and median net farm incomes for all farms with useable data over the last 43 years. Starting in 2007, NFI greatly increased over what it had been. In particular, the highest earning farms saw their NFI increase even faster. This can be seen where the average NFI exceeds the median NFI. In 2015, NFI fell to levels not seen since the farm crisis of the 1980s. In 2016 and 2017, NFI improved some but is still low (after accounting for inflation) when compared with the period from 1987 to 2006.

Figure 2 shows how family living has changed over time. This figure has nominal dollars and also spending adjusted by the CPI index to reflect inflation effects. The bar in the figure represents spending as if all dollars were adjusted to 2017 levels. In real dollar terms it can be observed that spending was in the range of $50,000 to $55,000 until the boom in grain prices in 2007. Family living started to increase in response to higher NFI, but it wasn't immediate and lagged by a year or two the increase in NFI. Unfortunately, the response in family living to declining NFI has been slower than the decline in NFI. In addition, the percentage drop in NFI has been greater than the percent drop in family living.

The big drop in net farm income combined with the higher levels of family living means that farms may not be able to cover family living from NFI alone. Fortunately, many farms have non-farm income to support any NFI/family living imbalances. However, the level of non-farm income is quite variable among KFMA farms. As shown in Figure 3, the lowest one-third of farms (based on three levels of non-farm income), have median non-farm income of $10,000, while the highest one-third of farms have median non-farm income of nearly $90,000.

## METHODS

The KFMA farms with certified family living data were further tested by examining the amount spent on food. Those farms with food expenditures less than $1,500 were thrown out despite being certified as useable. This was done to ensure good quality data went into the analysis. After filtering the data, approximately 300 farms were left for family living analysis.

The next step was to divide the farms into thirds based on the level of non-farm income. For each year, the amount of non-farm income was ranked from highest to lowest. The largest one-third of farms by non-farm income were placed into the "high" category, the next one-third were in the "medium" category, and the lowest were in the "low" category. After grouping, each third was analyzed by specific expense item by averaging those farms within each third.

## RESULTS

Figures 4, 5, and 6 show how the three non-farm income groups spent their money for family living categories. There are at least four points that can be seen by examining the graphs in combination with each other. First, entertainment and recreation is now one of the biggest expense categories for all farm families, while food, which used to be the major expense item, is now lower on the list. This might be partially explained by a shift from eating at home to eating out (eating out is considered entertainment and recreation as opposed to food). Second, those families with the highest level of non-farm income have not reduced their recreation expense, while the lower two groups have. Third, health insurance has increased at a faster rate than almost all other categories for all three groups andnow represents the first or second highest expense for all farm families. At the same time, medical expenses have remained fairly constant, so at least the health insurance is not leaving any more out of pocket medical expense. Fourth, some expenses, such as home repairs, were quick to adjust to a lower net farm income. These types of expenses might be considered "low hanging fruit," as they are probably easy to adjust should net income drop.

The total of these family living expenses is shown in Figure 7. Those farms in the highest group of non-farm income do have higher living expenses and have been slower to adjust their family living expenses downward. The average difference between the family living of the highest non-farm income group and the lowest non-farm income group is $6,500 in real dollar terms since 1993.

Farms with different levels of non-farm income might be expected to have different levels of NFI as well. Because those farms with lower non-farm income have family living expenses only $6,500 less than the high non-farm income group, net farm income should be higher for the low non-farm income group. This is based on the observation that a non-farm income difference of $65,000 exists between the high and low group, while the high group has additional family living expenses of $6,500. The low non-farm income group would need net farm income to be $58,500 greater than the high non-farm group for the two groups to be on equal footing.

Farms with the lowest non-farm income do have greater NFI. These farms on average have net farm income that is about $40,000 more than the farms with the highest level of non-farm income. Despite this higher level of NFI, the farms with the lowest level of non-farm income still have less income available after taking out family living. That is, the combination of NFI plus non-farm income minus family living is lowest for the low non-farm income group.

## DISCUSSION

When net farm income is above average, the amount that a family spends for family living expenses is rarely a concern. However, when net farm income starts to drop below average, then family living becomes more important. Not only is there less available income from the farm to pay for family living but family living often lags changes in net farm income. When NFI is increasing, this is not a problem, but when NFI is decreasing, the lag is especially a concern. A drop is NFI means less income is available to meet family living, and the family living itself hasn't readjusted yet to account for the drop.

Fortunately, many farm families have some level of non-farm income. However, this amount of non-farm income can vary considerably. The difference between the high and low thirds of non-farm income is $65,000. Those farms with the lowest level of non-farm income will face more variability in their income and are more at risk to downturns in the farm economy. Fortunately, this low non-farm income group is also the quickest to adjust their family living.

While family living is trending downward, it is still nearly the inflation adjusted family living that existed before the high net farm income years that started in 2007. Family living as a whole for the state is still about $10,000 higher than it was pre-2007. With medical insurance increasing so rapidly and being so high for many farm families, it is doubtful that farm families can ever get their family living to levels that existed before 2007. Medical insurance costs have to be a concern to everyone but especially farm families that don't have insurance from an outside-the-farm job. For farm families that are forced to pay for medical insurance, spending in other expense categories will have to be monitored whenever net farm income starts to trend lower.

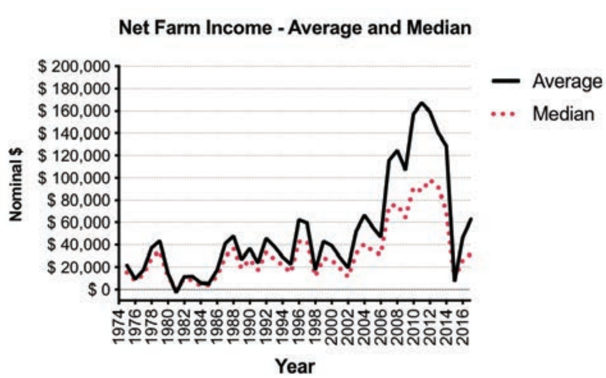


Figure 1. Median and Average Net Farm Income for KFMA Farms

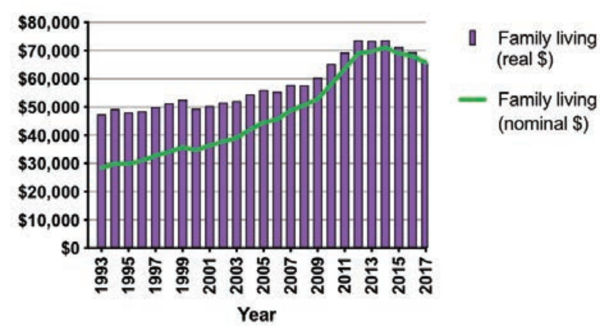


Figure 2. Family Living Expenses for KFMA Farms – Nominal and Real Dollars

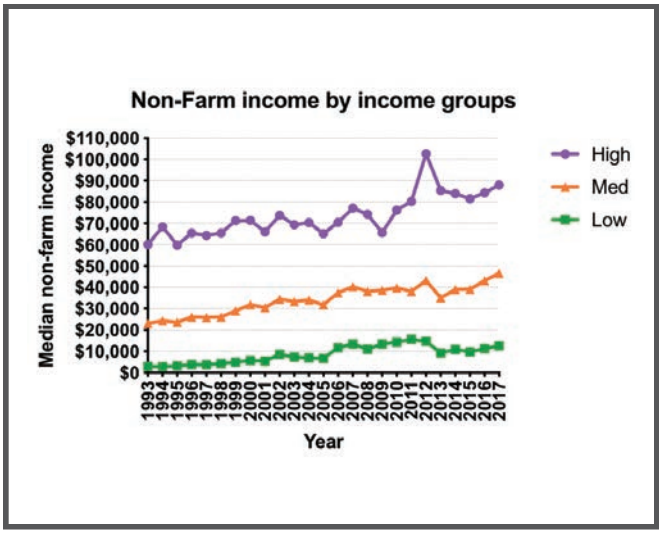


Figure 3. Median Non-Farm Income for KFMA Farms by Level of Non-Farm Income

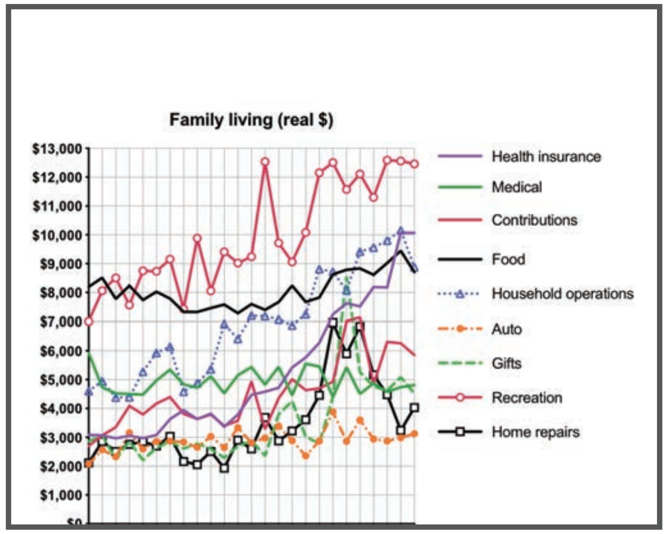


Figure 4. Family Living Expense Items for High Level of Non-Farm Income

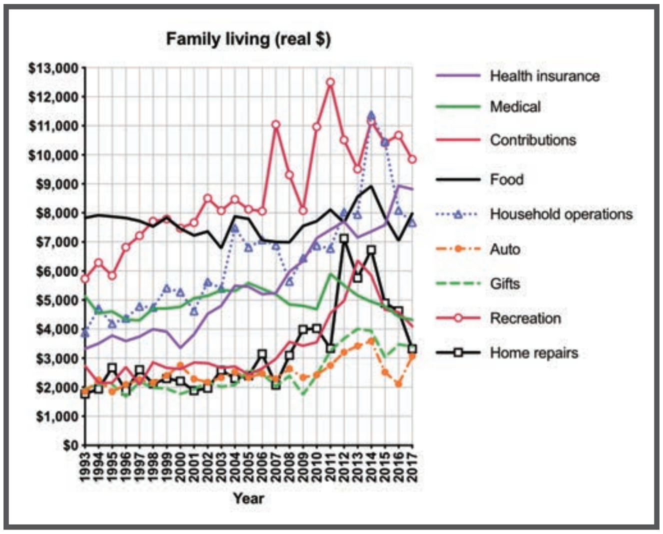


Figure 5. Family Living Expense Items for Middle Level of Non-Farm Income

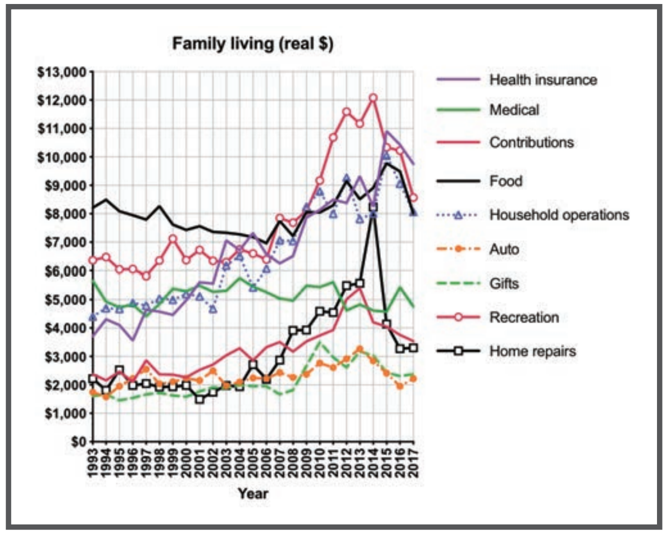


Figure 6. Family Living Expense Items for Low Level of Non-Farm Income

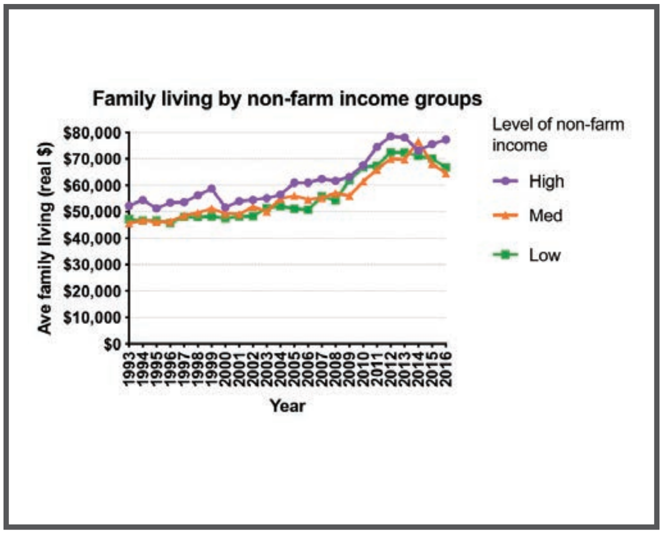


Figure 7. Total Family Living by Level of Non-Farm Income

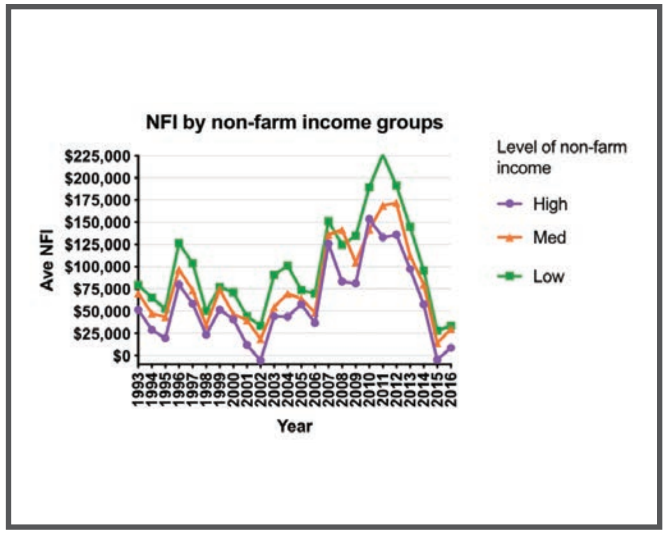


Figure 8. Net Farm Income by Level of Non-Farm Income

# Factors Affecting Net Farm Income for Row Crop Production in Kansas





**By Emily Carls, Gregory Ibendahl, Terry Griffin, and Elizabeth Yeager**

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## Acknowledgements

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## Abstract

*Low commodity prices combined with high input costs have deteriorated net farm income over the last several years. As a result, management decisions have become extremely important, as any less than optimal decision could result in the farm losing money. Understanding which factors of production have the greatest effect on net farm income can help producers focus their efforts. This study analyzed various factors affecting net farm income to determine those that were most important to the profitability of an operation. Results varied depending upon the set of years analyzed and the region of the state. This may reflect an environment where the factors important to a top farm vary by the overall condition of the farm economy.*


## INTRODUCTION

American agricultural production has a long history of highly variable net farm income (NFI). After NFI peaked in 2013, there has been a steady decline over the last four years (USDA, ERS). These downward and upward movements in net farm income have made effectively managing farms difficult for producers, as those management choices that affect NFI can be difficult to analyze because of all the income variability that producers face. With current low commodity prices, producers are being forced to be more efficient in other areas of production (machinery, inputs costs, etc.). This has made it even more difficult for producers to determine those management decisions that are important to long-run profitability.

Extension professionals are assisting producers to improve profitability by providing the latest research, guidance for farm decisions, and software tools to aid in their decision-making. However, without a full understanding of specific factors affecting net farm income, this can be challenging. With increased knowledge, Extension personnel could make better recommendations for farmers or improve overall profitability (Stabel et al., 2017).

Several factors that influence NFI are outside of the producers' control. These include trade, government subsidies, fiscal policy, interest rates, and the weather. Though uncontrollable, these factors are important to consider when making farm-level management decisions. However, there are farm-level decisions that are within the control of producers including, but not limited to: machinery, production management, investment, and financial decisions. Understanding which of these factors has the greatest effect on NFI can aid producers in making farm-level management decisions.

The overall goal of this analysis was to estimate the factors that predict net farm income to help farmers find areas where they can adjust their operations so that they can increase their profitability. Because this is a beginning analysis into this area of farm management decisions, not all management factors are included, and the analysis is limited to a descriptive comparison of farms, years, and region of the state.

## DATA

This analysis used data from the Kansas Farm Management Association (KFMA) database. The KFMA has served Kansas producers for over 80 years and currently has nearly 2,500 farmer-members (O'Brien & Yeager, 2017). In a given year, there are approximately 1,500 farms that have useable data. This study analyzed 17 years of data from 2001 to 2016. In all, 476 unique farm observations were evaluated. The variables used in the model are shown in Table 1. This is certainly not a complete list of all variables that might be important, but as this is an initial exploration of factors, it represents a first take. A three-year average of all the variables was used in order to account for weather variations from year to year.

The data were split into three regions, the east, central, and west regions of the state of Kansas. This dividing into regions was necessary to account for the lower NFI per acre as one moves from east to west across the state. Rainfall across Kansas is responsible for this change from east to west. Quintile groups were created based on NFI per acre. To create a quintile, the farms were ranked in order of NFI per acre. The highest NFI quintile was labeled as Quintile 1 with the remaining quintiles labeled in order from Quintile 2 through Quintile 5. These variables included crop acreage, percent of acres rented, corn yield, debt to asset ratio, working capital per acre, and fertilizer cost per acre.

## RESULTS AND DISCUSSION

As an initial step in the analysis, pairwise correlations were calculated for all variables from the 2016 data. Correlations above 0.5 or below −0.5 were further evaluated. The variables with the highest positive correlation were machinery cost and machinery investment. Machinery investment was defined as the average of the beginning and ending remaining basis values for all machinery and equipment used in crop production. Machinery cost was defined as the variable costs of production with respect to machinery (repair and maintenance, fuel, oil, etc.). These variables had a correlation of 0.83 indicating that the capital invested in machinery is also expressed in the costs associated with machinery use.

The second highest correlated set of variables were machinery cost and crop production costs with a correlation of 0.79. This shows us how highly impactful machinery costs are on overall crop production costs. The third highest correlated set is crop production costs and fertilizer costs, with a correlation of 0.72. Similar to machinery costs, this depicts the significance of fertilizer costs on overall crop production costs. Lastly, debt to asset ratio and working capital per acre had a correlation of −0.54 meaning they were negatively correlated. This indicates that there is a give and take between paying off debt and keeping cash on hand in working capital. Plots of these correlations can be seen in the Appendix.

The next step in the analysis was to examine selected factors of production by quintiles at various time points and regions of Kansas. Average crop acres for the top quintile in 2016 for the central region were 1,190 acres compared to 1,637 acres for the bottom quintile. In 2001 acreage levels were 1,254 acres for Quintile 1 and 1,141 acres for Quintile 5, a reversal of which quintile had more acres. During the 16 years examined for the central region, the middle quintile tended to have the most acres. The top quintile tended to have either the fewest or the second fewest acres. Thus, it is difficult to make any conclusions about the number of crop acres having an impact on overall profitability. Certainly, crop acres are not the driving factor behind net farm income. This is demonstrated in Figure 1.

In the eastern region of the state, Quintile 5 is consistently and significantly below the rest of the quintiles (Figure 2). In 2016, Quintile 1 had 1,750 acres while Quintile 5 had 1,331. Similarly, in 2001 the top quintile has 1,166 acres and the bottom quintile has 876 acres. There is consistently higher variation in the western portion of the state. In 2016 the top quintile has an average of 3,382 acres while the bottom quintile has 2,459. In 2001 the bottom quintile had higher acreage at 1,945 acres versus 1,917 for the top quintile.

For the central and eastern portions of Kansas, the percent of land rented for Quintile 1 were consistently a lower percentage of acres than Quintile 5 and the other quintiles as well (Figures 3 and 4). The western portion of the state was more variable in the movement between quintiles, and it is not clear that the most profitable farms own more crop acres. This would indicate that in the eastern two-thirds of the state, owning more of your farmland is more profitable.

Figures 6 and 7 are used to show how yields affect profitability. Quintiles for corn yields in the central and eastern portion of the state are highest for the most profitable farms and lowest for the least profitable farms. The yield ranking actually matches the quintile ranking for most years. In 2016 Quintile 1 in the central region had an average corn yield of 115 bushels per acre compared to approximately 90 bushels per acre for Quintile 5. Without statistical analysis we can still see that this is a significant difference in yields between quintiles. This indicates that yields are a driving factor for net farm income because Quintile 1 consistently had the highest yields. However, identifying what production factors, such as irrigation, tillage, seed selection, and land quality, affect yields needs to be further considered. This ranking of quintile by yields occurs with other crops as well.

Figures 8, 9, and 10 are used to show how the amount of debt affects profitability. Again, the western region does not agree with the eastern two-thirds of the state. In general, for the eastern and central region of the state, less debt means more profitability. There is a clear trend that at each lower profitability quintile, the amount of debt is higher. This holds true for most of the years. This holds true in the western region as well from 2007 to present. However, from 2001–2004 Quintile 1 has the highest debt to asset ratio. After discussion with producers this variance could be attributed to expansion in the early 2000s that was paid off quickly because of high commodity prices from 2007 onward. However, a more in-depth analysis would be needed to confirm.

The next to last measure examined was the working capital per acre. Across all regions it is shown that working capital per acre is consistently higher for Quintile 1 as opposed to Quintile 5. This is demonstrated in Figures 11 through 13. There is more variation in the western region between the quintiles; however, it is noted that Quintiles 1 through 3 are consistently higher than Quintiles 4 and 5.

The final measure examined was fertilizer cost. These quintiles don't show very much separation until the late 2000's. However, across all regions there is a noticeable separation in the quintiles from 2007 to present. This is shown in Figures 14 through 16. Low commodity prices combined with a continued increase/non-decreasing input prices could explain some of this separation however, further analysis would need to be done to confirm.

## CONCLUSION

This preliminary analysis has indicated that owning more land and having less debt could be important to overall profitability. However, getting to that point could be difficult. One point not examined is the age of producers. As producers age, they tend to pay down debt and perhaps own more of their land as well.

Another key factor was the yields. Our preliminary analysis shows that the most profitable farms had the best yields. Whether this was from better soil or high input use is not totally clear. The most profitable farms tended to use more fertilizer, but whether this was from producers pushing their land harder or because they had better soil and fertilized more cannot be determined. Further investigation is needed to see the soil types of each farm.

Lastly, the higher levels of working capital among the most profitable farms presents another "chicken and egg" situation. Do the most profitable farms have higher working capital because they are making higher profits or do the higher levels of working capital give the top farms more flexibility to make better decisions? Again, more research is needed.

## REFERENCES

O'Brien, C., and E.A. Yeager. 2017. "Reductions in Working Capital and Resulting Burn Rates for Producers." *Journal of the ASFMRA*. 2017:97–111.

Stabel, J., T.W. Griffin, and G. Ibendahl. 2018. "Do Profitable Farms Remain Profitable? Markov Switching Models Applied to Transition Probabilities." *Journal of Applied Farm Economics*, 2(1):23–31

USDA Economic Research Service. 2017. U.S. net farm income forecast to stabilize in 2017 after declining in the prior 3 years. https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=76952.

**Table 1: Description of Variables**

| Crop Acres | The number of acres on a given farm |
|---|---|
| Operator Age | Age of operator on a given farm |
| Percent of acres rented | The number of cash and share rent acres divided by the total crop acres |
| Soybean Yield | Soybean yield in bu/acre |
| Corn Yield | Corn yield in bu/acre |
| Wheat Yield | Wheat yield in bu/acre |
| Sorghum Yield | Sorghum yield in bu/acre |
| Debt to Asset Ratio | Total liabilities divided by total assets |
| Machinery Investment | Average of the beginning and ending remaining basis values |
| Working Capital per acre | Current assets minus current liabilities divided by total acres |
| Machinery Cost | Crop share of machinery repairs, gas-fuel-oil, auto expense, motor vehicle depreciation, listed property depreciation, and machinery and equipment depreciation plus crop machine hire expense plus an opportunity interest charge on crop machinery investment minus machine work income |
| Total Crop Production Cost | Equal to total crop expense plus opportunity cost charge on listed property, motor vehicles, machinery and equipment, and buildings minus unpaid family and operator labor minus interest paid minus cash farm rent minus opportunity cost charge on net worth minus machine work income |
| Total Capital Managed | Total farm assets plus value of rented land |
| Fertilizer Cost | Represents the operator's share of accrual fertilizer and lime expense |

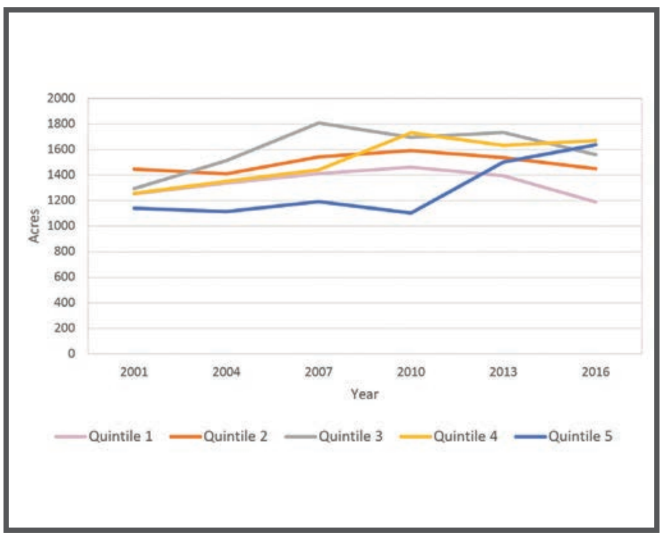


Figure 1: Crop Acres for the Central Region

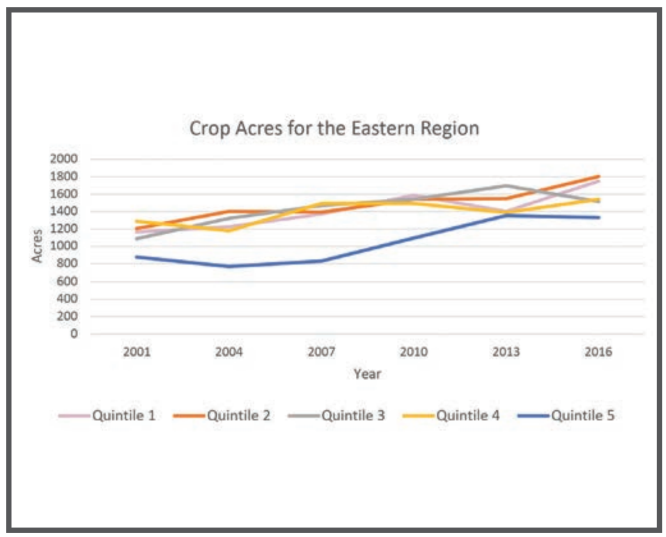


Figure 2: Crop Acres for the Eastern Region

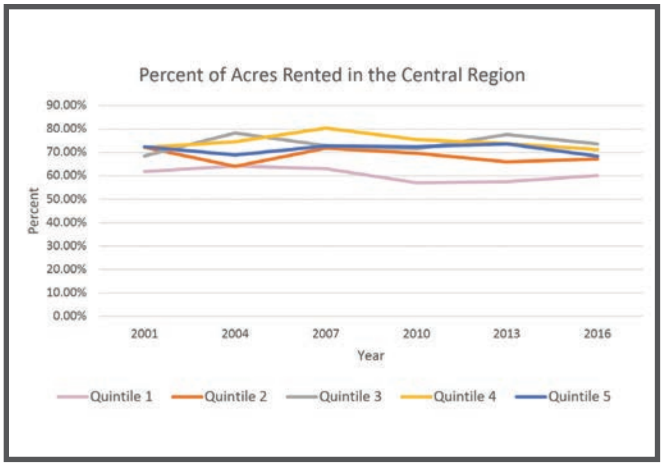


Figure 3: Percent of Acres Rented in the Central Region

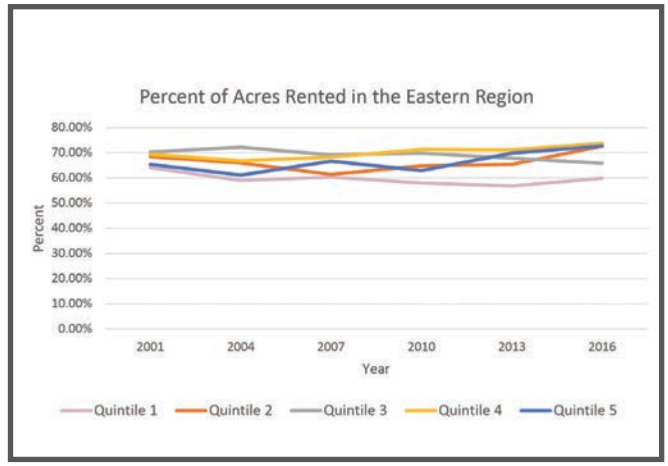


Figure 4: Percent of Acres Rented in the Eastern Region

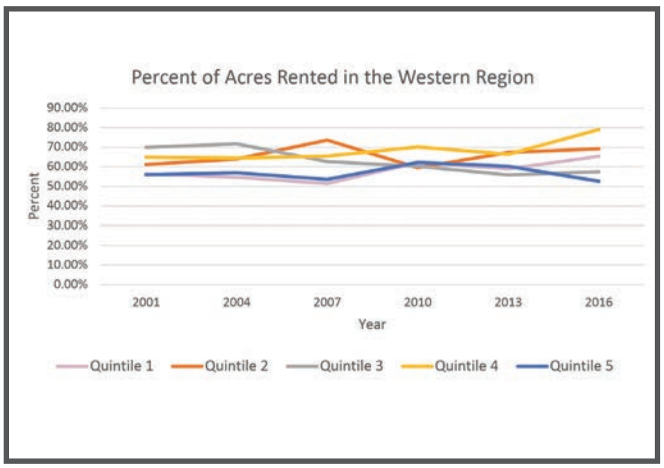


Figure 5: Percent of Acres Rented in the Western Region

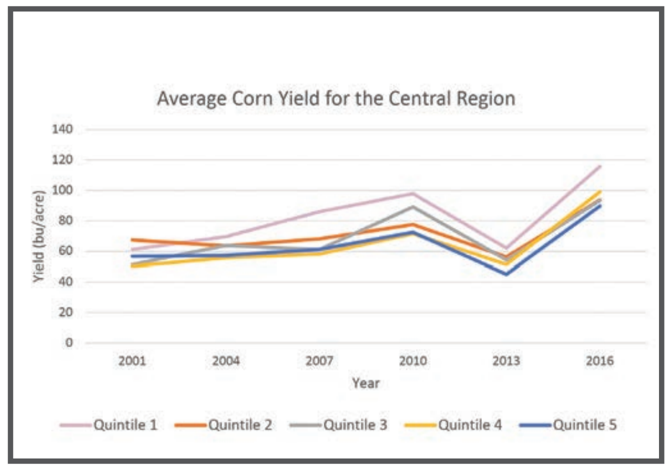


Figure 6: Corn Yields for the Central Region

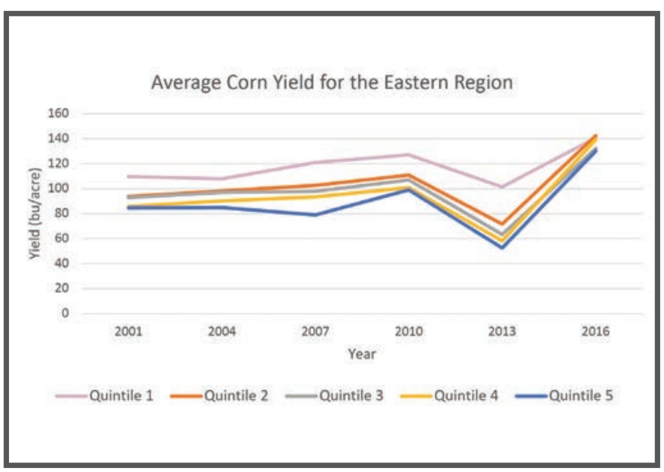


Figure 7: Average Corn Yields for the Eastern Region

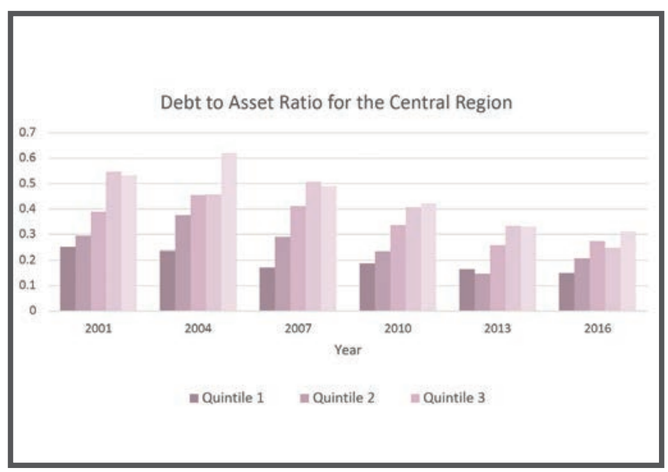


Figure 8: Debt to Asset Ratio for the Central Region

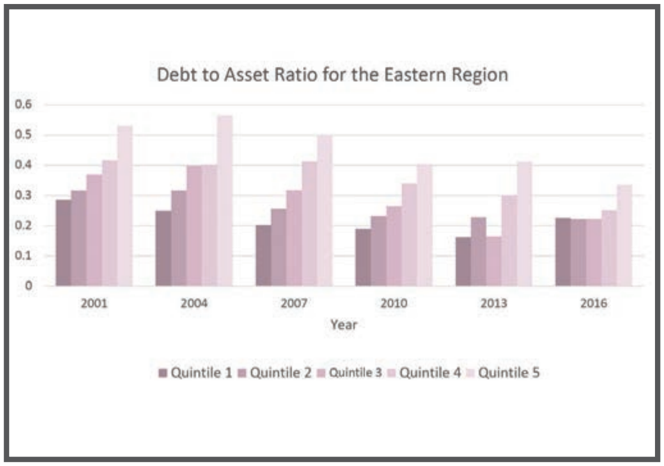


Figure 9: Debt to Asset Ratio for the Eastern Region

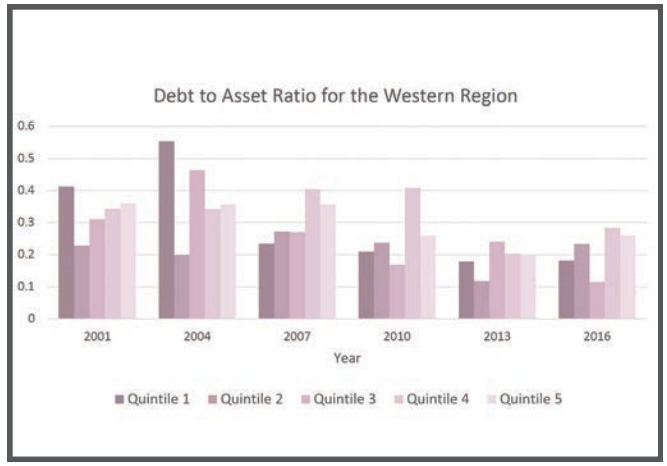


Figure 10: Debt to Asset Ratio for the Western Region

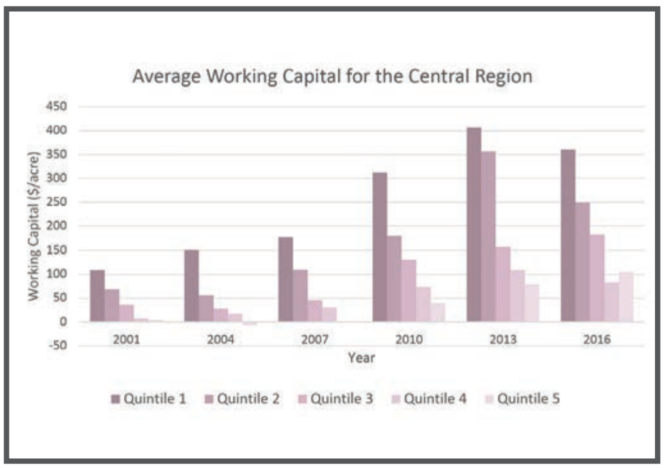


Figure 11: Working Capital per acre for the Central Region

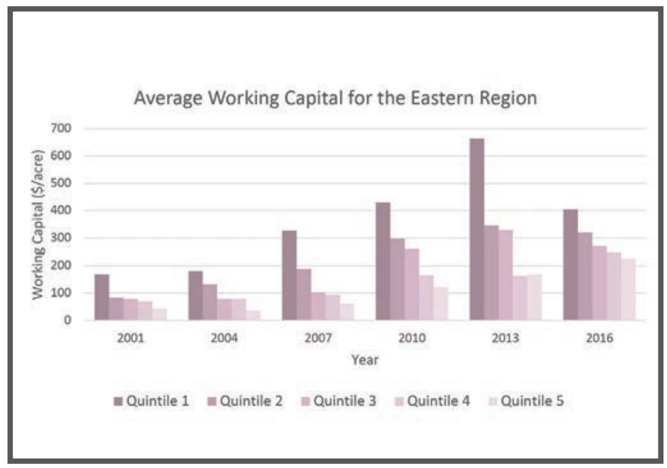


Figure 12: Working Capital per acre for the Eastern Region

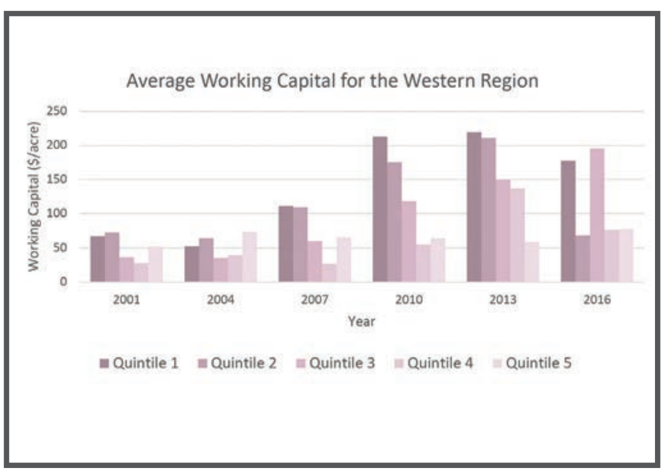


Figure 13: Working Capital per acre for the Western Region

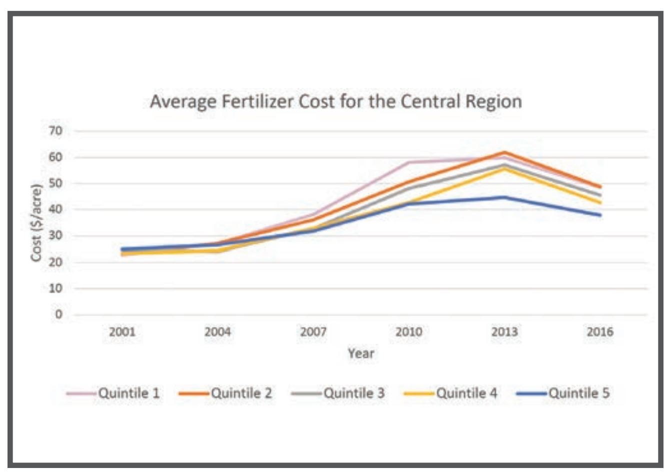


Figure 14: Fertilizer Cost for the Central Region

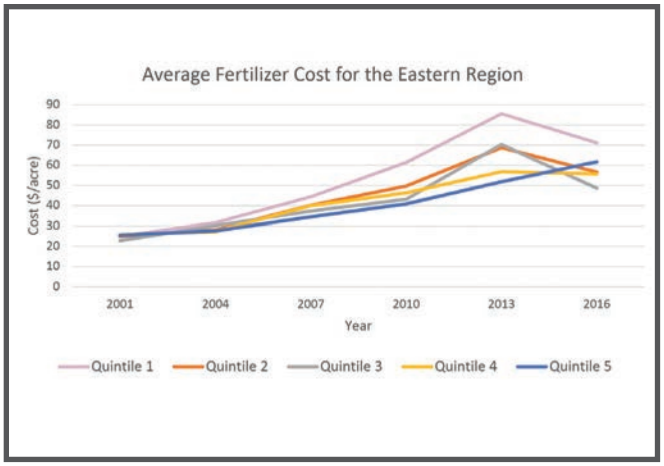


Figure 15: Fertilizer Cost for the Eastern Region

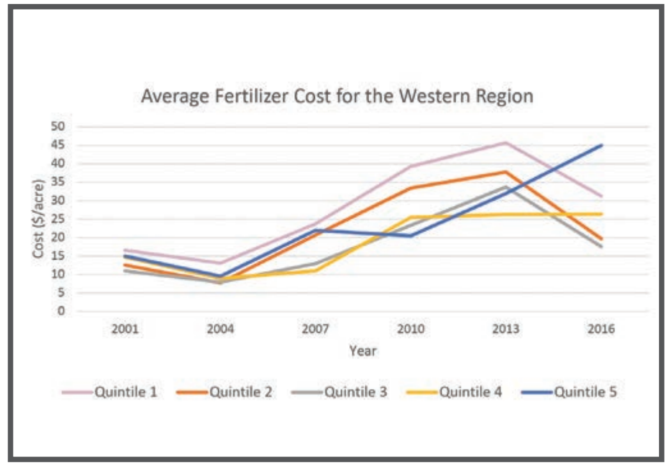


Figure 16:Fertilizer Cost for the Western Region

# Feedlot Size, Backgrounding Behavior, and Management Practices

**By Matthew A. Diersen and Scott W. Fausti**

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## Abstract

*A survey of feedlot owners was conducted to identify whether management differences exist between small and large feedlots. The results suggest several differences exist by size, but with mixed profit implications. At larger sizes, feedlots use direct sales, which may provide marketing premiums when selling fed cattle. At smaller sizes, placements often come from the operation’s own calf crop. Thus, cattle are on feed for a relatively long time, suggesting trade-offs among capacity utilization, labor availability, and feed availability. Backgrounding is prevalent for many feedlot operations, with shorter feeding durations and prevalent use of auctions compared to finishing operations.*

## INTRODUCTION

The conventional wisdom is that farms are becoming larger and more specialized. Cattle feedlots are noted as an exception, in part because consolidation happened decades ago. The spatial distribution of cattle herds and the labor intensity of ranching operations may limit the pace of consolidation. Farmer feedlots straddle the extremes, as they face some cost pressures that encourage consolidation but often have a dispersed land base for calf and feed production. Smaller feedlots have declined in numbers but have not disappeared. To gauge the factors that may influence the behavior of these operations, a survey was conducted of small and medium-sized feedlots in South Dakota.

Specialization and efficiency are often associated with size. A farm focuses on a profitable enterprise, grows, gains efficiencies, and continues the cycle. Thus, notable differences in behavior across different size operations are expected. Feedlots of different sizes may source cattle differently, sell cattle differently, and use different management strategies. As the size of an operation increases, there may be a need to diversify to increase returns and to manage risk. The operation may become large enough to profitably add a different enterprise. Because of scale economies, it may have excess labor or feedstuffs without an additional enterprise. Economies of scope may mean a cost advantage could be realized by adding a related enterprise.

The purpose of this article is to explain the differences and similarities across feedlot sizes. There are statistically significant differences in the methods used to buy, feed, and sell cattle, based on the capacity of the feedlot. Larger feedlots are more likely than smaller feedlots to use different selling methods. Larger feedlots are less able to rely on an operation-raised calf crop to supply the feedlot. Regardless of size, finishing an operation-raised calf crop usually implies a relatively light placement weight and a relatively long feeding duration. A long feeding period reduces the number of turns and may force a trade-off between operating at full capacity and continuing to feed operation-raised calves. Many surveyed feedlots also or in contrast have a backgrounding enterprise. While this utilizes the feedlot, it does so for fewer pounds added to the animals and for shorter durations.

Following the literature review is a breakdown of the survey results.1 The results follow the basic format of the survey that focused on the ownership and sources of placements and on the buyers and sales methods for finished and backgrounded cattle. The results for general feedlot management practices are also discussed. The results are compared to similar surveys, primarily Schulz (2014), USDA (2013b), and USDA (2013a). The primary statistical method is contingency table analysis, where chi-square results support observations about similarities and differences between small and large feedlots.

## LITERATURE

Extensive feedlot consolidation happened in the 1980s following consolidation among beef processors (Barkema & Drabenstott, 1990). However, there was not extensive consolidation among cow-calf operations at that time. Economies of size and a shift in location of feedlots resulted in feedlots becoming larger (Krause, 1991). The continued decline in the smallest feedlots, those with less than 1,000 head, was documented by MacDonald and McBride (2009). MacDonald, Hoppe, and Newton (2018) show the dichotomy of fewer feedlots, but not of fewer cow-calf operations. In recent decades there has been a large increase in the sales midpoint for feedlots, but only a small change in the midpoint inventory level of beef cows. A lack of consolidation among landholdings of grazing land is a potential reason that cow herds remain smaller.

Popp, Faminow, and Parsch (1999) looked at reasons for retaining ownership. They found that the size of the farm positively influences retaining ownership, but the size of the cow herd did not have an influence. Those backgrounding perceived it as a profitable enterprise. Those not feeding agreed that a lack of facilities hindered using the enterprise. Anderson et al. (2004) argued for the diversification effects of a backgrounding or stocker enterprise. A simulation of returns was used to show that ownership brings the greatest reward, but also the greatest risk when using the enterprise. Nehring et al. (2014) found that stockers can complement profitability for cow-calf producers.

Using a survey of stocker producers, Johnson et al. (2010) found that size of the enterprise affects the likelihood of adopting management practices. Larger operations were more likely to implant cattle, adjust the stocking rate, administer intramuscular injections, seek a uniform marketing lot size, and use risk management tools, compared to the smallest operations. Pruitt et al. (2012) used the Agricultural Resource Management Survey and found greater adoption of various management practices when the size of the cow herd was larger. The adoption was seen as evidence of economies of size. When the operations backgrounded, ran stocker cattle or finished cattle, they were also more likely to adopt the practices, indicative of economies of scope.

## STRUCTURE

A mail survey was designed in collaboration with the National Agricultural Statistical Service (NASS). NASS designed a stratified random sampling methodology for disseminating the survey instrument. A bi-variate sampling stratification procedure was used; South Dakota feedlots with less than 1,000 head capacity versus feedlots with a capacity over 1,000 head. Survey results provide a statistically reliable depiction of the South Dakota feedlot industry for 2015.

The initial survey question was whether the operation had cattle and calves on feed during 2015. There could have been operations that sat idle during 2015. Respondents were then asked for their feedlot capacity on Jan. 1, 2016. In the sample, the capacity ranged from 2 to 4,500 head. The 397 feedlots had a total capacity of 182,533 head for an average of 460 head per lot (Table 1). The common size delineation for feedlots is 1,000 head. The sample contains 38 large feedlots with total capacity of 74,089 head or an average of 1,950 head per lot. The sample contains 359 small feedlots with total and average capacity of 108,444 head and 302 head per lot, respectively.

A common practice in the region is to place cattle on feed in a backgrounding program. This may entail a feeding regimen similar to that in a finishing program, a regimen designed to grow the animal's frame to set it up for further feeding, a regimen designed to prepare the animal for grazing, or something that utilizes available feedstuffs on the operation (such as silage). In the sample, 181 respondents had placements of cattle for finishing and 277 respondents had placements for backgrounding (Table 1).

Respondents were asked about operated acres, land use, and the inventory of any beef cows. After deleting missing and/or inconsistent responses, the remaining

383 respondents had an average of 2,374 operated acres. There was a wide range of owned and leased acres. The mix of operated acres showed a fairly even division between cropland and pastureland acres. The number of beef cows is only across the subsample of 331 respondents that reported having beef cows. Of those, the average was 191 head of cows. For comparison, the average farm size in South Dakota in the 2012 *Census of Agriculture* was 1,352 acres. Of operations with beef cows, the average number of cows was 239 head.

The survey only contained questions about capacity, not of inventory. The survey results are not directly comparable to the *Census of Agriculture*, which tallies inventory levels across farms. In 2012 there were 1,263 farms in South Dakota with a total of 418,374 cattle on feed. This compares to 1,793 farms with a total of 517,783 cattle on feed in 2007.

Across all feedlots, the number placed for finishing exceeded the number placed for backgrounding (Table 2). However, when split by feedlot size (capacity), the number placed for backgrounding exceeded the number placed for finishing for small feedlots. When split by feeding practice, the proportion backgrounded was higher for smaller feedlots.

## OWNERSHIP OF CATTLE FOR FINISHING

Respondents were asked for ownership shares of placements. These shares were used to weight the placements to obtain an implied number of head by ownership type. The majority of cattle placed for finishing were owned by the feedlot (Table 3). There were 175 feedlots with at least some sole-ownership, totaling 79,484 head. There were 11 feedlots with some co-ownership, totaling 3,108 head. Sole ownership of cattle was prominent regardless of the size of the feedlot. For comparison, USDA (2013a) found that for feedlots with 1,000–7,999 head capacity, the share of cattle owned by the feedlot was 67.7 percent in 2011. They also reported the share (combined) for jointly and custom fed was 30.9 percent of cattle.

Custom feeding was more prevalent in larger feedlots. Only 11 of the 181 feedlots, or 6.1 percent, had custom fed cattle (Table 3). Across those there was a total of 11,670 head placed. Of the 11, six had capacity less than 1,000 head and five had capacity of 1,000 or greater head. Of the 11, only three were solely finishing custom cattle. For comparison, in the 2012 Census of Agriculture, 55 farms reported custom fed cattle (for slaughter) totaling 134,884 head in South Dakota. Only 3.3 percent of farms with feedlot sales had custom fed cattle, but they accounted for 21.3 percent of the head of cattle sold in 2012.

### Placements

The ownership of cattle was also reflected in the source of placements. The most frequent sources of cattle were an operation's own calf crop and auction barns (Table 4). Smaller feedlots had the highest percentage share of implied aggregate cattle from the calf crop. Larger feedlots had the highest percentage shares of each of the other methods. The aggregate shares are similar to Taylor and Feuz (1994). USDA (2013a) found that auctions were an even more prominent source for larger feedlots, followed by custom fed sources. A very small (aggregate) share of cattle, only 3.3 percent nationally, came from an operation's own calf crop. For smaller lots, USDA (2013b) found a higher share sourced from auctions and a lower share from an operation's calf crop. In Iowa, Schulz (2014) found a lower proportion of feedlots sourcing from their own calf crop and larger proportions sourcing from order buyers and directly from other operations.

Respondents reported placement and sale weights of steers and heifers. However, placements were not gathered by gender. Often weights were given only for steers or heifers. The number of placements was used to weight the animal weights across ownership shares. There were eight observations with unusually light finish weights. These were removed from the calculations.

Using the implied number of steers and heifers placed by respondents, a weighted average placement weight was computed across feedlot sizes (Table 5). For individual respondents there was commonly a 25 or 50 pound heavier in-weight reported for steers than for heifers. This pattern still holds in aggregate. For all feedlots, the average steer weighed 14 pounds more than the average heifer when placed. At finishing, the steers were substantially heavier, averaging 1,459 pounds, compared to 1,376 pounds for heifers. The sample range of finished weights for large feedlots was 1,250–1,600 pounds for steers and 1,200–1,500 pounds for heifers. Small feedlots placed cattle at lighter weights and sold cattle at lighter weights compared to large feedlots. The pattern, especially for lighter placement weights, is not unexpected because the source of the cattle in smaller feedlots is primarily from the operations' own calf crops.

For comparison, in the *Cattle on Feed* statistics for large feedlots at the national level in 2015, over one-third of placements were in the 800+ pound category. In addition, USDA (2013a) has a breakdown of placements by small feedlots in categories of less than 700 pounds and equal to or more than 700 pounds. In 2011, across breeds and genders, 76 percent of cattle placed by small feedlots weighed less than 700 pounds.

The Agricultural Marketing Service (AMS) reports volume and weights of cattle sold at various locations. The weighted average weight of feeder cattle sold at AMS-reported South Dakota sale locations in 2015 was 717 pounds for steers, 692 pounds for heifers, and 707 pounds across both. In Nebraska, the 2015 yearly weighted average live steer weight for direct sales was 1,444 pounds per head with a range of 1,150–1,775 pounds. For heifers the average was 1,328 pounds per head with a range of 1,050–1,600 pounds.

The averages mask the substantial variability in placement and sale weights across feedlots (see appendix figure A). For feedlots that are using their own calf crop (partly or in full), they are usually adding about 800 pounds of weight, implying a long feeding period at typical rates of gain. This would limit the ability to keep the lot at full capacity or to continue to use the bunk space for the following year's calf crop.

Without inventory data, a proxy was calculated for turns. The ratio of the placements to capacity was compared to overall capacity (Figure 1). The proxy has an average of 0.72 for all feedlots with any finished cattle. For smaller feedlots the average falls to 0.65, while for larger feedlots the average was 1.13. Having more than a single turn was uncommon but varied by size. Having excess or underutilized capacity was common. Taylor and Feuz (1994) found a similar pattern in 1991, as feedlots in South Dakota had capacity utilization of 84.1 percent in the first quarter and 57.7 percent in the third quarter of the year. At that time, the target weight for steers averaged 1,223 pounds.

## Sales Methods and Buyers

Respondents were asked about the type of pricing method used for finished cattle sold during 2015. As methods, they could be mutually exclusive categories. Thus, exclusive use of a single sales method would exclude use of another. As a result a number of respondents may have stopped answering (or being asked) once "always" was chosen for a given price method. Differences by size, 24 large feedlots and 143 small feedlots, convey more information than the full sample (Table 6). A cascade effect is evident in the increasing number of non-responses down the list.

Using categorical data analysis, there are statistically significant differences between feedlot sizes based on the number using each method.2 Smaller feedlots more often selected always using cash sales on a live [weight] by the pen method to sell finished cattle, compared to larger feedlots. Because smaller feedlots also used auctions, the method and location were consistent. In contrast, the larger feedlots would use the cash market sometimes, but forward markets also. Larger feedlots more often selected sometimes or always using the other cash methods, forward contracting and formula grid pricing methods, compared to smaller feedlots. Thus, at some size level there is a greater frequency of using other pricing methods. Respondents could enter "other" selling methods, which included using auction or sale barns, selling to individuals, selling by dressed weight of individual carcass, and forward-contracting in a niche market. The results are similar to those for live- and dressed-negotiated pricing as Schulz (2014).

Buyer types used mirror the pricing methods used. The differences by size, 24 larger feedlots and 143 smaller feedlots, convey more information than the full sample (Table 7). Larger feedlots predominantly used direct sales [to packers], with 75 percent always doing so. Larger feedlots were significantly more likely to select sometimes or always using direct sales, compared to smaller feedlots. Smaller feedlots were significantly more likely to select always using auctions, compared to larger feedlots. A small percent of smaller feedlots used other methods, listing buyers that included friends, neighbors, and other individuals. Use of an order buyer was not prevalent across feedlot sizes. At the national level, small feedlots used direct sales (auctions) on over two-thirds (less than one-third) of shipments (USDA, 2013b).

# CATTLE FOR BACKGROUNDING

Of the 397 respondents, 277 had placements of cattle and calves for backgrounding during 2015, or 70.0 percent of the sample (Table 8). For the larger capacity feedlots with any backgrounding, a couple of the largest lots had a high portion of custom fed cattle. Thus, the share of custom fed higher for the group of larger feedlots is high compared to the large feedlots with any finished cattle. The results are not directly comparable to Hodur et al. (2007), as a large portion of their sample included replacement heifers.

Of those backgrounding, 90 percent (249 of 276) of the feedlots were sourcing calves from their own calf crops (Table 9). Compared to those with any cattle for finishing, there was a smaller percentage of lots using an auction barn to source calves. The share of head from different sources is consistent with backgrounding lots feeding their own calf crops. The share of head, at 59.7 percent of placements, was greater for backgrounding lots than for finishing lots. The pattern was more pronounced across sizes, as smaller feedlots with backgrounding heavily concentrated the source of calves as their own calf crops.

Respondents reported placement and sale weights of steers and heifers of cattle placed for backgrounding. The observations were weighted by ownership and gender mix. Across 15 observations the finish weights were above the average for finished cattle. Thus, an arbitrary limit of 1,200 pounds was used. Both for steers and heifers the weights ranged from a minimum of 80 pounds to a maximum of 1,200 pounds. The average weights were closer to expectations (Table 10). The average in- and out-weights for steers were 515 and 834 pounds, respectively. For heifers the average in- and out-weights were 484 and 793 pounds, respectively. Across capacity sizes, the placement weights were similar. However, the larger feedlots had higher sales weights. The placement and sale weights varied substantially across capacity levels (see appendix figure B).

Of those backgrounding any cattle, the respondents were asked if they sold any such cattle in 2015. Only 214 feedlots reported selling backgrounded cattle in 2015, likely in response to all-time record high calf prices in late 2014. In contrast to sales of finished cattle, backgrounded cattle were predominantly sold using an auction (Table 11). Types such as direct sales and order buyers were sometimes used, in percentages similar to finishing observations. Larger feedlots were statistically more likely to sometimes use direct sales, compared to smaller feedlots. Several respondents listed "private treaty" for a buyer type, which would have been considered a direct sale if made to a commercial feedlot. Despite the shorter duration of backgrounding compared to finishing, there proxy for turns did not increase. Only 18 percent of those backgrounding had a turn greater than 1.0, while 29 percent of those finishing had a turn greater than 1.0.

## PRACTICES

General feedlot management practices questions were designed with a binary response. Respondents either indicated yes or no to a given practice (Table 12). There were some differences depending on the size of the operation. With respect to animal health issues, larger feedlots were statistically more likely to consult a nutritionist or veterinarian and maintain a hospital pen relative to smaller feedlots. For smaller feedlots, the proportions using a nutritionist or a veterinarian were higher than USDA (2013b). With respect to using a Beta Agonist, larger feedlots were statistically more likely to use this growth supplement (26 percent) compared to 6.1 percent of smaller feedlots. The latter is similar to the level in USDA (2013b). Shares were similar across feedlot sizes for those that maintained medical records and visually sorted cattle for market rather than relying on ultra-sound. Respondents were asked their participation in Beef Quality Assurance (BQA). For the full sample, 43.1 percent of respondents completed BQA certification. The share of those with BQA was sharply higher and statistically different among larger feedlots compared to smaller feedlots.

Respondents were asked how frequently they used various feeds in 2015. Usually, the respondents used farm-raised crops (Table 13). Larger feedlots were statistically more likely to select always using feed from other local producers, compared to smaller feedlots. Thus, production practices suggest the larger feedlots specialize somewhat on the feedlot enterprise.

## CONCLUSIONS

Significant differences exist in the overall management of different size feedlots. However, the profitability of these differences is ambiguous. Larger feedlots tend to use outside sources for calves, place and sell cattle at heavier weights, and operate closer to feedlot capacity than smaller feedlots. In contrast, smaller feedlots rely on the operation's calf crop and predominantly use auctions to sell finished cattle.

Larger feedlots are more specialized than smaller feedlots. At a larger size, they more often use direct sales for finished cattle, perhaps giving them a marketing advantage compared to smaller feedlots. Larger feedlots also use outside sources for services and feed supplies. In essence, the feedlots focus on feeding cattle and let others focus on health, nutrition, and feed production.

Many feedlots in the sample were predominantly backgrounding lots, ranging from a short preconditioning period to a relatively long feeding period. Such feedlots often fed operation-raised cattle or sourced cattle from an auction. At sale time, the auction was the predominant outlet.

Regardless of feedlot size or type of feeding, the feedlots often fed their own, operation-raised, cattle for long durations to achieve desired sales weights. These feedlots often trade off capacity utilization for labor- and feed-utilization, as many filled the feedlot to capacity one time. The feeding duration, especially for those finishing cattle, would preclude multiple turns. Thus, for many of these feedlots, the enterprise is a way to diversify the overall operation. While the pressure to operate at an efficient size may continue to lead to larger feedlots, smaller feedlots fill a niche by using locally available feedstuffs and economies of scope, especially at the backgrounding level.

The survey results provide insight on the current structure and management practices of the South Dakota feedlot industry. This information will be of value to current feedlot operators, agricultural policy experts, agricultural lenders, and valuation experts.

## REFERENCES

Anderson, John D., Curt Lacy, Charlie S. Forrest, and Randall D. Little. "Expected Utility Analysis of Stocker Cattle Ownership Versus Contract Grazing in the Southeast." *Journal of Agricultural and Applied Economics* 36, 3 (December 2004): 719–730.

Barkema, Alan D., and Mark Drabenstott. "A Crossroads for the Cattle Industry." *Economics Review – Federal Reserve Bank of Kansas City* 75, 6 (Nov/Dec 1990): 47–66.

Fienberg, S.E. *The Analysis of Cross-Classified Categorical Data*. Cambridge, MA: The MIT Press, 1980.

Hodur, N.M., F.L. Leistritz, D.J. Nudell, C. Clark, D. Griffith, and T. Jensen. *Northern Great Plains Beef Production: Production and Marketing Practices of Cow-Calf Producers*. Agribusiness & Applied Economics Report No. 609, Department of Agribusiness and Applied Economics, North Dakota State University, Fargo, ND, August 2007.

Johnson, Rachel J., Damona Doye, David L. Lalman, Darrell S. Peel, Kellie Curry Raper, and Chanjin Chung. "Factors Affecting Adoption of Recommended Management Practices in Stocker Cattle Production." *Journal of Agricultural and Applied Economics* 42, 1 (February 2010): 15–30.

Krause, Kenneth R. *Cattle Feeding, 1962–89: Location and Feedlot Size*. Agricultural Economic Report No. 642, Economic Research Service, U.S. Department of Agriculture. April 1991.

MacDonald, James M., Robert A. Hoppe, and Doris Newton. *Three Decades of Consolidation in U.S. Agriculture*. EIB-189, Economic Research Service, U.S. Department of Agriculture. March 2018.

MacDonald, James M., and William D. McBride. *The Transformation of U.S. Livestock Agriculture: Scale, Efficiency, and Risks.* EIB-43, Economic Research Service, U.S. Department of Agriculture. January 2009.

Nehring, Richard, Jeffery Gillespie, Charles Hallahan, James Michael Harris, and Ken Erickson. "What is Driving Economic and Financial Success of U.S. Cow-Calf Operations?" *Agricultural Finance Review* 74, 3 (2014): 311–325.

Popp, Michael P., Merle D. Faminow, and Lucas D. Parsch. "Factors Affecting the Adoption of Value-added Production on Cow-Calf Farms." *Journal of Agricultural and Applied Economics* 31, 1 (April 1999): 97–108.

Pruitt, J. Ross, Jeffrey M. Gillespie, Richard F. Nehring, and Berdikul Qushim. "Adoption of Technology, Management Practices, and Production Systems by U.S. Beef Cow-Calf Producers." *Journal of Agricultural and Applied Economics* 44, 2 (May 2012): 203–222.

Schulz, Lee L. Iowa Beef Center 2014 Feedlot Operator Survey. Extension and Outreach Publications. 94. 2014. https://lib.dr.iastate.edu/extension_pubs/94

Taylor, D.C., and D.M. Feuz. *Cattle Feedlot Management in South Dakota.* Economics Research Report 94-1, Economics Department, South Dakota State University, Brookings, SD, March 1994.

USDA. *Feedlot 2011 "Part III: Trends in Health and Management Practices on U.S. Feedlots, 1994–2011."* USDA-APHIS-VS-CEAH-NAHMS. Fort Collins, CO., #637.0413, July 2013a.

USDA. *Feedlot 2011 "Part II: Management Practices on U.S. Feedlots with a Capacity of Fewer than 1,000 Head."* USDA-APHIS-VS-CEAH-NAHMS. Fort Collins, CO., #627.0313, March 2013b.

## ENDNOTES

1. The survey instrument and summary discussion are available in Diersen, Matthew A., and Scott W. Fausti. "Small- and Medium-Sized Feedlots: Management and Marketing Survey Results." (2017). Economics Research Reports. 86. https://openprairie.sdstate.edu/econ_research/86.

2. For a discussion of Chi-Square ($\chi^2$) test, see Feinberg (1980). The test p-values were evaluated at the 0.05 level.

**Table 1. Distribution of Feedlots by Size and Practice**

| | Number of Lots | Average Capacity (Head per Lot) | Total Capacity (Head) |
|---|---|---|---|
| All | 397 | 460 | 182,533 |
| Large (1,000+ Head) | 38 | 1,950 | 74,089 |
| Small (< 1,000 Head) | 359 | 302 | 108,444 |
| | | | |
| Any Finished | 181 | 521 | 94,262 |
| Any Backgrounded | 277 | 281 | 77,896 |

| Table 2. Distribution of Placements by Size and Feeding Practice | | | |
|---|---|---|---|
| **Capacity and Practice** | **Number of Feed-lots** | **Placements for Finishing** | **Placements for Backgrounding** |
| All | 397 | 94,262 | 77,896 |
| < 1,000 Head | 359 | 32,953 | 54,426 |
| 1,000+ Head | 38 | 61,309 | 23,470 |
| | | | |
| Any Finish | 181 | 94,262 | 18,499 |
| < 1,000 Head | 155 | 32,953 | 12,399 |
| 1,000+ Head | 26 | 61,309 | 6,100 |
| | | | |
| Any Backgrounded | 277 | 15,275 | 77,897 |
| < 1,000 Head | 261 | 7,606 | 54,426 |
| 1,000+ Head | 16 | 7,669 | 23,470 |

| Table 3. The Implied (Weighted) Breakout of Placements for Finishing by Ownership | | | | | | |
|---|---|---|---|---|---|---|
| **Capacity** | **Sole-ownership Lots** | **Co-ownership Head** | **Custom Fed Lots** | **Head** | **Lots** | **Head** |
| All | 175 | 79,484 | 11 | 3,108 | 11 | 11,670 |
| 1,000+ | 23 | 51,911 | 2 | 968 | 5 | 8,431 |
| <1,000 | 152 | 27,573 | 9 | 2,140 | 6 | 3,239 |

Note: n = 94,262 head.

| Table 4. Sources of Placements for Finishing Across Feedlot Sizes | | | | | | |
|---|---|---|---|---|---|---|
| | **All (n = 176) Counts** | **Large (n = 23) Share (%)** | **Small (n = 153) Counts** | **Share (%)** | **Count** | **Share (%)** |
| Own Calf Crop | 134 | 30.9 | 13 | 24.3 | 121 | 41.5 |
| Order Buyer | 22 | 13.5 | 9 | 15.3 | 13 | 10.6 |
| Auction Barn | 61 | 31.7 | 11 | 34.1 | 50 | 27.9 |
| Video Auction | 5 | 2.9 | 4 | 4.4 | 1 | 0.3 |
| Direct Purchase | 16 | 5.1 | 3 | 4.3 | 13 | 6.4 |
| Custom Fed | 12 | 15.9 | 6 | 17.6 | 6 | 13.2 |

Notes: n = 84,254 head after removing incomplete and inconsistent responses from 5 observations. There were also small changes after removing 3 other observations with inconsistent shares of custom fed cattle.

| Table 5. Weighted-Average In- and Out-Weights of Cattle Placed for Finishing | | | | | | |
|---|---|---|---|---|---|---|
| | **All (n = 176)** | | **Large (n = 26)** | | **Small (n = 150)** | |
| | **In-Weight** | **Out-Weight** | **In-Weight** | **Out-Weight** | **In-Weight** | **Out-Weight** |
| | **(Pounds per Head)** | | | | | |
| Steers | 695 | 1,459 | 736 | 1,468 | 589 | 1,435 |
| Heifers | 681 | 1,376 | 715 | 1,386 | 589 | 1,351 |

| Table 6. Pricing Methods for Finished Cattle Sold | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Counts | Large (n = 24) | | | | Small (n = 143) | | | |
| | | Some- | | No | | Some- | | No |
| | Never | times | Always | Resp. | Never | times | Always | Resp. |
| Cash Market | | | | | | | | |
| Live Wt.* | 7 | 9 | 4 | 4 | 29 | 23 | 82 | 9 |
| Dressed* | 7 | 9 | 3 | 5 | 89 | 25 | 19 | 10 |
| Grid* | 11 | 6 | 2 | 5 | 117 | 11 | 5 | 10 |
| Forward Contract | | | | | | | | |
| Live Wt.* | 7 | 4 | 2 | 11 | 68 | 9 | 1 | 65 |
| Dressed* | 5 | 4 | 4 | 11 | 71 | 8 | 0 | 64 |
| Grid* | 8 | 3 | 1 | 12 | 74 | 2 | 1 | 66 |
| Formula Priced | | | | | | | | |
| Live Wt. | 8 | 1 | 1 | 14 | 69 | 7 | 2 | 65 |
| Dressed | 8 | 1 | 0 | 15 | 70 | 8 | 0 | 65 |
| Grid* | 6 | 1 | 2 | 15 | 74 | 4 | 1 | 64 |

Note: * The $\chi^2$ statistic by feedlot size was significant with a p-value less than 0.05.

| Table 7. Buyer Types for Finished Cattle Sold | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Counts | Large (n = 24) | | | | Small (n = 143) | | | |
| | | Some- | | No | | Some- | | No |
| | Never | times | Always | Resp. | Never | times | Always | Resp. |
| Direct Sales* | 1 | 5 | 18 | 0 | 80 | 20 | 40 | 3 |
| Order Buyer | 17 | 3 | 0 | 4 | 113 | 22 | 5 | 3 |
| Auction* | 13 | 6 | 2 | 3 | 32 | 32 | 78 | 1 |
| Other | 20 | 0 | 0 | 4 | 126 | 6 | 5 | 6 |

Note: * The $\chi^2$ statistic by feedlot size was significant with a p-value less than 0.05.

| Table 8. The Implied (Weighted) Breakout of Placements Placed for Backgrounding | | | | | | |
|---|---|---|---|---|---|---|
| | Sole-ownership | | Co-ownership | | Custom Fed | |
| Capacity | Lots | Head | Lots | Head | Lots | Head |
| All | 256 | 51,358 | 30 | 4,665 | 22 | 16,731 |
| 1,000+ | 9 | 6,350 | 3 | 1,070 | 6 | 11,050 |
| <1,000 | 247 | 45,008 | 27 | 3,595 | 16 | 5,681 |

Note: n = 72,754 head after removing incomplete and inconsistent responses in 2 observations.

| Table 9. Sources of Placements for Backgrounding Across Feedlot Sizes | | | | | | |
|---|---|---|---|---|---|---|
| | All (n = 276) | | Large (n = 15) | | Small (n = 261) | |
| | Counts | Share (%) | Counts | Share (%) | Count | Share (%) |
| Own Calf Crop | 249 | 59.7 | 9 | 22.6 | 240 | 72.3 |
| Order Buyer | 16 | 5.5 | 3 | 1.6 | 13 | 6.8 |
| Auction Barn | 34 | 11.3 | 2 | 16.8 | 32 | 9.5 |
| Video Auction | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Direct Purchase | 10 | 2.2 | 0 | 0.0 | 10 | 2.9 |
| Custom Fed | 18 | 21.3 | 5 | 59.0 | 13 | 8.5 |

Note: n = 72,896 head after removing an incomplete response in 1 observation.

| Table 10. Weighted-Average In- and Out-Weights of Placed for Backgrounding | | | | | | |
|---|---|---|---|---|---|---|
| | All (n = 262) | | Large (n = 13) | | Small (n = 249) | |
| | In-Weight | Out-Weight | In-Weight | Out-Weight | In-Weight | Out-Weight |
| | (Pounds per Head) | | | | | |
| Steers | 515 | 834 | 521 | 874 | 513 | 819 |
| Heifers | 484 | 793 | 480 | 834 | 485 | 783 |

| Table 11. Buyer Types for Backgrounded Cattle Sold | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Counts | Large (n = 24) | | | | Small (n = 143) | | | |
| | Never | Some-times | Always | No Resp. | Never | Some-times | Always | No Resp. |
| Direct Sales | 8 | 1 | 0 | 2 | 173 | 20 | 4 | 6 |
| Order Buyer* | 6 | 3 | 0 | 2 | 174 | 17 | 6 | 6 |
| Auction | 0 | 2 | 7 | 2 | 11 | 24 | 166 | 2 |
| Other | 9 | 0 | 0 | 2 | 162 | 5 | 3 | 33 |

Note: * The $\chi^2$ statistic by feedlot size was significant with a p-value less than 0.05.

| Table 12. Select Management Practices across Feedlot Sizes | | | |
|---|---|---|---|
| **Counts** | **Yes** | **No** | **No Resp.** |
| **Large (n = 38)** | | | |
| Nutritionist* | 36 | 1 | 1 |
| Veterinarian* | 37 | 0 | 1 |
| Hospital Pen* | 37 | 0 | 1 |
| Medical Records | 33 | 3 | 2 |
| Beta Agonist* | 10 | 27 | 1 |
| Ultra-Sound | 3 | 34 | 1 |
| Visual Sort | 34 | 3 | 1 |
| Beef Quality Assurance (BQA)* | 25 | 12 | 1 |
| **Small (n = 359)** | | | |
| Nutritionist | 264 | 86 | 9 |
| Veterinarian | 316 | 36 | 7 |
| Hospital Pen | 211 | 135 | 13 |
| Medical Records | 279 | 71 | 9 |
| Beta Agonist | 22 | 324 | 13 |
| Ultra-Sound | 23 | 327 | 9 |
| Visual Sort | 306 | 46 | 7 |
| Beef Quality Assurance (BQA) | 146 | 198 | 15 |

Note: * The $\chi^2$ statistic by feedlot size was significant with a p-value less than 0.05.

| Table 13. Select Feeding Practices | | | | |
|---|---|---|---|---|
| **Counts** | **Never** | **Sometimes** | **Always** | **No Resp.** |
| **Large (n = 38)** | | | | |
| Own Crop | 1 | 4 | 32 | 1 |
| Local Farm* | 11 | 11 | 15 | 1 |
| Local Firm | 17 | 14 | 6 | 1 |
| **Small (n = 359)** | | | | |
| Own Crop | 11 | 18 | 326 | 4 |
| Local Farm | 186 | 128 | 36 | 9 |
| Local Firm | 208 | 106 | 35 | 10 |

Note: * The $\chi^2$ statistic by feedlot size was significant with a p-value less than 0.05.

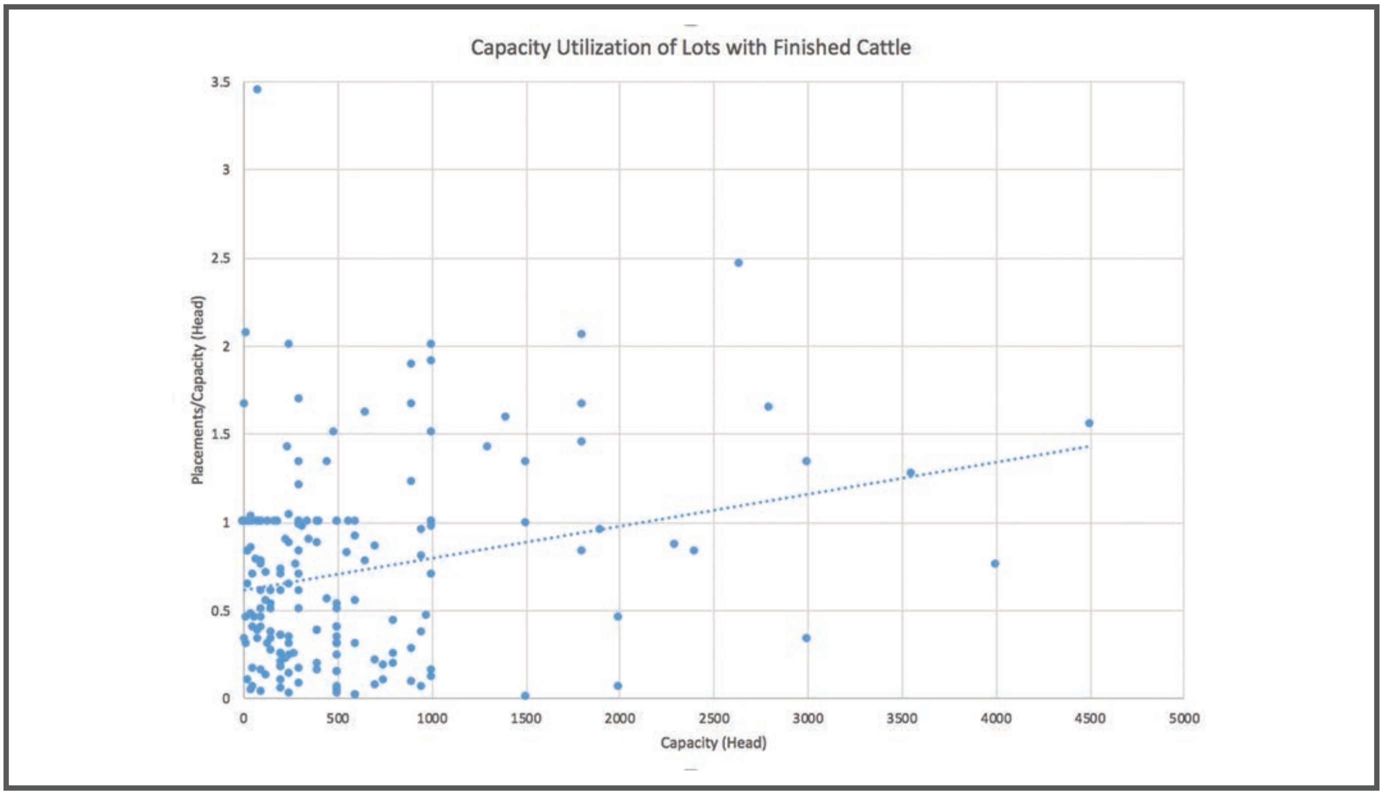
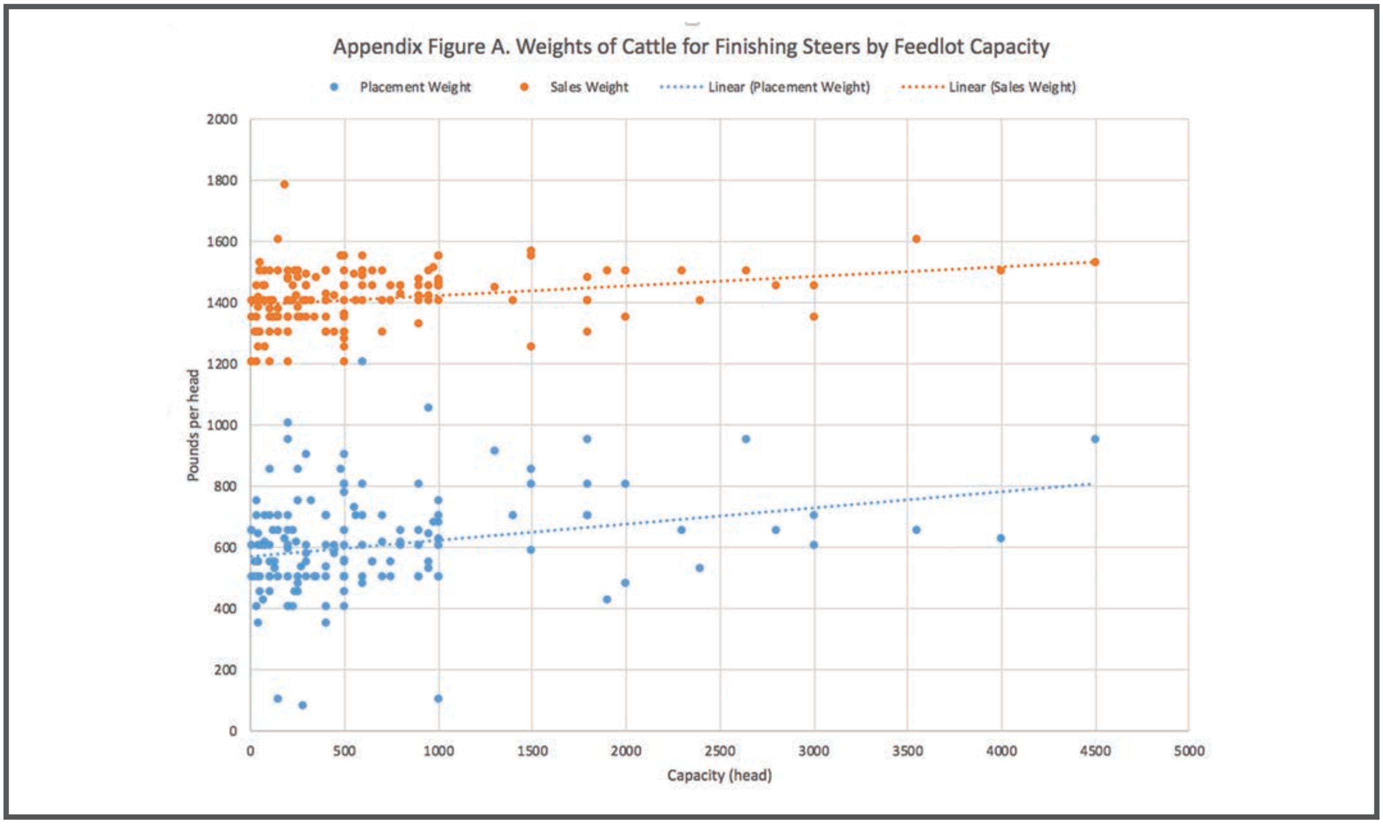
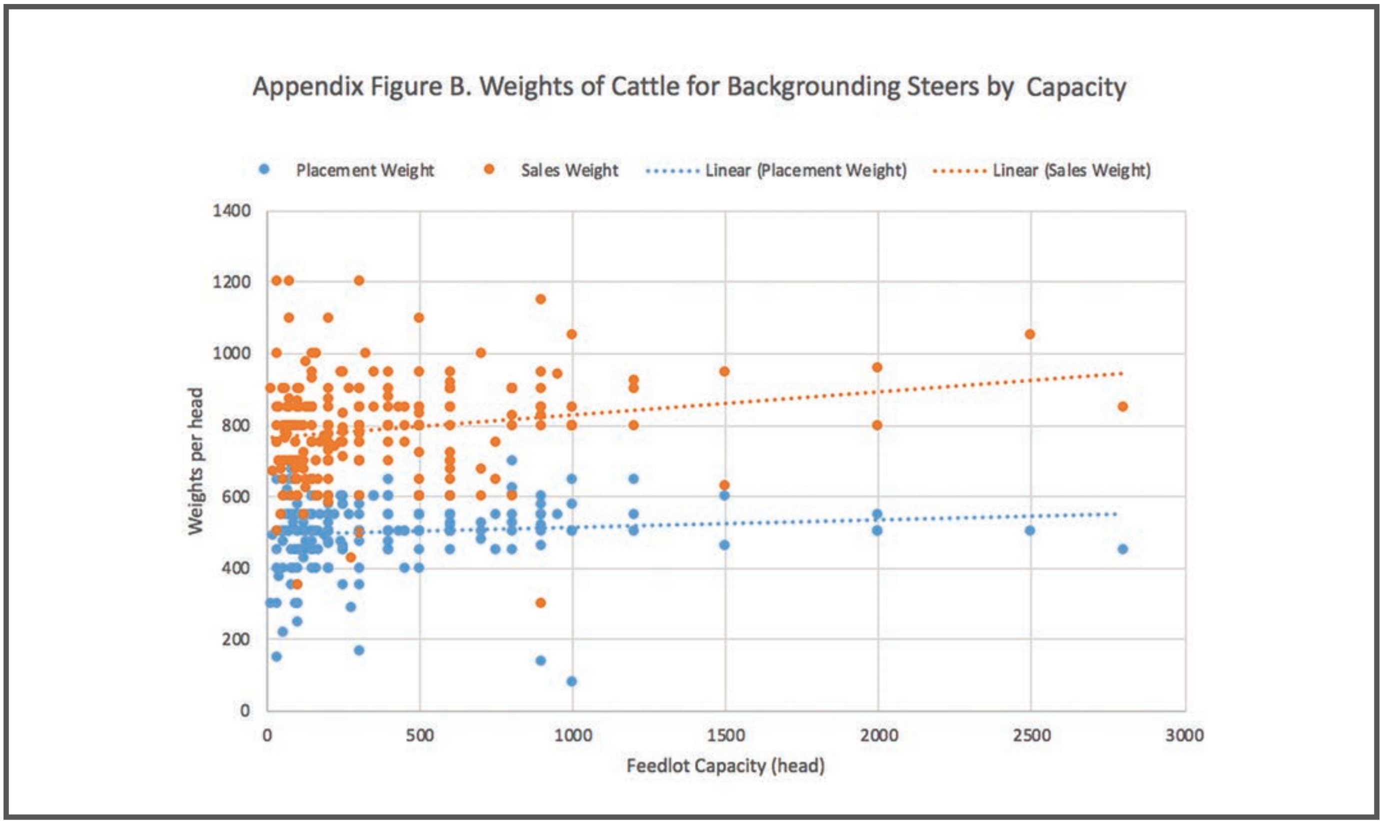



Figure 1: Capacity Utilization of Lots with Finished Cattle




Appendix Figure A: Weights of Cattle for Finishing Steers by Feedlot Capacity




Appendix Figure B: Weights of Cattle for Backgrounding Steers by Capacity

# Impact of Agricultural Extension on Irrigated Agriculture Production and Water Use in California

**By Diti Chatterjee, Ariel Dinar, and Gloria González-Rivera**

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## Abstract

*University of California Cooperative Extension (UCCE) disseminates irrigation information with the aim of enhancing productivity, using irrigation-efficient technology and water management practices. We estimate the impact of UCCE as a source of irrigation information and knowhow, on irrigated agriculture production and water use for California's farmers. Using census data from 2003 and 2008, we find positive effects of UCCE on irrigated agriculture production ($3,035/acre), and water use rise (1.17 acre-feet/irrigated acre), suggesting selection of more profitable cropping patterns that, through the use of water-saving irrigation systems, increase the average value of output per irrigated acre.*

## INTRODUCTION

Climate change can potentially alter agricultural systems (Parry et al., 2004) and affect yield quantity and quality of annual as well as perennial crops via rising temperatures and shifting patterns in precipitation (Adams et al., 2001; Southworth et al., 2000; Lobell et al., 2006). Climate change will result also in an increased demand for irrigation water because of the combination of decreased rainfall and increased evaporation (Bates et al., 2008) and in a change in water quality (Masmoudi et al., 2010). Climate change, therefore, has and is expected to have a considerable impact on the agricultural sectors of the western coast of the U.S., especially in the Southwest, which already experiences harsh climatic conditions. California's agricultural sector, which depends on irrigation, will need to adapt to these changes in the future.

The agriculture sector in California is the largest consumer of water for irrigation, accounting for 80 to 90 percent of human water usage (Olen et al., 2015). California's agricultural sector produced $53.5 billion in total value of sales receipts in 2014 (California Agricultural Statistics Review, 2014–2015). Water is one of the main inputs in California's agricultural production. The state has experienced many droughts, which affected agricultural productivity in the short and long run.

The University of California Cooperative Extension (UCCE) has been working on research aimed at improving productivity and resource use in the state (Chatterjee et al., 2018). Irrigation efficiency has been an important subject in the UCCE disseminated knowledge portfolio since the 1950s (Hayden-Smith & Surls, 2014), when farm advisors started working on applying water based on soil and crop type. Each county office in the UCCE system has developed and implemented irrigation programs over the years to help farmers with irrigation information, such as irrigation requirements for various crops, soil types, and weather conditions.[1] Over time emphasis has been given to water conservation technologies, because of water shortage issues in California. Farm advisors have introduced irrigation technologies that reduce water wastage and improve yields, such as sprinkler and drip irrigation. UCCE personnel have been responsible for the introduction of drip irrigation in San Diego county (Taylor et al., 2014), which later spread to other parts of the state and the country. According to Taylor et al. (2014), UCCE's efforts in implementing drip irrigation in California have led to $78 million to $238 million in annual water savings. Allen-Diaz (2009) reports that UC-led researchers have developed a technique that increases drought tolerance in plants, which can help farmers maintain productivity as well as make irrigation more sustainable.

The University of California and the California Department of Water Resources have developed a network of monitoring stations across the state — the California Irrigation Management Information System (CIMIS), which has been operational since 1982,[2] to provide irrigation requirement estimates to farmers, based on crop evapotranspiration (ET), and other weather conditions. Parker et al. (2000) estimates that statewide benefits outweigh the costs of operating CIMIS, and lead to reduction of water use by nearly 100,000 acre-feet, annually. Parker and Zilberman (1996) report that CIMIS led to higher gains for farms with modern irrigation technologies, and it is more effective for high value crops in terms of cost-benefit considerations. UCCE efforts toward improving irrigation efficiency have been significant in the state of California. Empirical studies aimed at estimating the overall impact of UCCE irrigation information on irrigated agriculture production and water use are rare.

The extension efforts (activities, number of factsheets and decision tools published, attendees and frequency of meetings, delivery methods, and platforms, etc.) are the mechanism by which UCCE disseminates the knowledge and affects its clientele. UCCE knowledge production consists of direct and indirect contacts with clients, its own research projects, and its publications. Over the period 2007–2013, the total number of counts of knowledge produced through all direct contact methods, statewide, rose from 15,059 in 2007 to 21,479 in 2011 and then it fell to 8,282. Total number of indirect contacts with growers in 2007 was 259,065, picked up to 405,386 in 2009, fell to 43,000 in 2010, and rose again to reach 100,919 in 2013. Own research projects and publications went down from 3,349 in 2007 to 506 in 2013. Distribution by county is available upon request (Chatterjee, et al., 2018).

In this paper, we empirically estimate the impact of UCCE as the farmers' source of irrigation information and knowhow on irrigation water use efficiency. We use the Farm and Ranch Irrigation Survey as our main data source (with several limitations discussed below). Our objective is to quantify the impacts of UCCE on agricultural outcome. Two variables of irrigation efficiency are used as outcome variables — total value of agricultural output per irrigated acre, and water applied per acre of irrigated land. We choose these two variables keeping in mind UCCE's role in working toward improved farmer productivity. Our irrigation efficiency models account for on- and off-farm water availability, irrigation systems installed in the farm, climate, available irrigation information sources, farmland characteristics, and demographic characteristics. For the empirical analysis, we use farm level data collected by United States Department of Agriculture (USDA) as part of the Farm and Ranch Irrigation Survey (FRIS). This data set is arguably the most comprehensive irrigation information data collected in the country. The results of our analysis shed light on the relationship between UCCE as a source for irrigation information and other inputs, on irrigated agriculture production as well as farmers' irrigation water use decisions in California. We also estimate the impact of farmer age on adoption of irrigation knowledge disseminated by UCCE. The paper contributes to the literature by providing quantitative evidence of the level of impact of UCCE toward irrigation efficiency in the state.

The remainder of the paper is organized as follows: Section 2 outlines the econometric methodology, followed by data description, and summary statistics. Section 3 analyzes the empirical results. We end the paper with conclusion and policy implications in section 4.

# 2. EMPIRICAL MODEL AND DATA

## 2.1 Empirical Model

We use two variables to represent farmers' irrigation water use efficiency: Total value of agricultural output per irrigated acre, and water use per irrigated acre. We estimate the impact of UCCE disseminated irrigation knowledge, and other factors, on each of these two variables. We use data for 2003 and 2008 taken from USDA-FRIS dataset as is explained below. Productivity is measured usually by yield per acre (Datt & Ravallion, 1998), and it includes both irrigated and unirrigated acres. However, we extend the notion of irrigation productivity by including only irrigated acres and denote value of yield per irrigated acre as a measure for productivity. Assuming profit maximizing farmers, we multiply the yields by market prices of each crop, to obtain the dollar equivalent value for each crop. All individual values are then aggregated, to create the total value of agricultural output for each farmer in our data set. Because we consider two periods of time, five years apart, part of the difference in value of agricultural sales between the two periods results from difference in output prices brought about by inflation, and not necessarily rise in agricultural productivity. Guiteras (2009) addresses this issue of price changes over time by using a constant price to calculate the value of agricultural output for different periods. Variation in the resulting variable captures the change in average value of output resulting from change in yields, and not prices. We follow this methodology in our analysis to eliminate the impact of inflation on value of agricultural output; and obtain the impact of UCCE on irrigated agriculture. We use value of agricultural sales to measure agricultural productivity in this paper, following a similar methodology in OECD (2001).[3]

The empirical model for irrigated agriculture described above represents farm level value of agricultural output per irrigated acre P as a function of: water availability *A*, irrigation system in the farm *I*, climate *C*, irrigation information system U, farmland characteristics *O*, and farmer demographics *D*. The model in its general form is represented by:

$$P_{it} = f(A_{it}, I_{it}, C_{it}, U_{it}, O_{it}, D_{it}) \qquad (1)$$

*where i = 1,....., I* is index of farms, and *t* = 2008, 2013, represents time.

The second model is a farm level model representing water used for irrigation, per acre of irrigated land. The covariates remain the same as in equation (1), but the dependent variable in this case is V, representing water usage per irrigated acre. The general form model is:

$$V_{it} = g(A_{it}, I_{it}, C_{it}, U_{it}, O_{it}, D_{it}) \qquad (2)$$

UCCE's irrigation scheduling services and outreach programs that encourage farmers to install water-saving irrigation systems are aimed at reducing irrigation water usage. These efforts have led to considerable amounts of water savings in California, according to Taylor et al. (2014), and Parker et al. (2000). However, not all water saved is returned to the sources, given the "use it or lose it" water allocation system in the state and the effective water constraint relative to land constraint, leading to an expansion effect (Dinar & Zilberman, 1991; Ward & Pulido-Velazquez, 2008), namely under non-limiting land resources any savings in water from use of more efficient irrigation technology will be translated to expansion of irrigated land and thus increased use of irrigation water on the farm.

Water availability variables are represented by vector *A* and include two variables: well depth of three primary wells used by the farm, and cost of off-farm surface water per irrigated acre. On-farm water availability is directly correlated with well depth, and cost of obtaining groundwater is a function of well depth (Caswell & Zilberman, 1986). We include a square term of well depth to understand how rising well depth will affect irrigated agriculture production and water use. Cost of off-farm water is an economic indicator of the farm's water availability. These variables are likely to affect a farmer's decision of irrigated agriculture production and water use.

The vector I includes dummy variables for each existing irrigation system used by farmers, such as gravity, sprinkler and drip, trickle and sub-irrigation systems. These variables measure whether the farmer used the said irrigation system on the farm. Gravity system, (furrow or basin irrigation), which is known to be water- inefficient, has been the traditional and preferred method of irrigation system in the last century. There has been a big push from the government to generate awareness among farmers, and to promote adoption of more water-conserving irrigation methods such as sprinkler and drip (Negri & Brooks, 1990; Caswell & Zilberman 1985).

Climate plays an important role in irrigation use efficiency and is represented by the vector C, which includes county level temperature and precipitation as covariates. Quadratic terms for each are introduced to capture second order effects (Schuck & Greene, 2001). Indicator variables representing farm level frost control and heat control measures are also included in C; farmers implement these measures to account for local weather changes, which affect irrigation water use efficiency decisions. There is evidence of frost damage to vegetables, such as potatoes (Grewal & Singh, 1980), and heat damage to field crops, such as alfalfa (Li et al., 2013) and maize (Hatfield & Prueger, 2015). Therefore, measures to control heat and frost damage likely affect productivity as well as water use and hence, are included as covariates in our model.

Irrigation information systems, represented by vector *U*, play an important role in educating farmers about environmental issues such as climate change and resource availability, and provide solutions to dealing with these issues. The irrigation information system included in our model is UCCE, our covariate of interest; it enters the model as a dichotomous variable indicating whether or not the source of irrigation information for the farmer is UCCE. It has been the most important source of freely available information for California farmers, and we expect to see positive impact of UCCE on irrigated agriculture production and volume of water applied.

Caswell and Zilberman (1986) mention that land quality, captured by our farmland characteristics variables *O*, is an important factor in the farmer's irrigation choice problem; hence it has bearing on irrigated agriculture production and volume of water applied. In this vector, we include variables such as crop mix and salinity of the soil. Crop mix is measured by the inclusion of dummy variables for different major crop types, which indicate whether the farm produced and harvested them. Soil salinity is captured through a dummy variable that indicates whether the farmer used irrigation water for leaching the soil of salts.[4]

Farmer demographic variables *D*, include farmer age, primary occupation of the farmer, whether the operation has a hired manager, and farmer experience. Dinar and Yaron (1990) report that older farmers with more experience are less likely to implement water-saving methods in their operations. Many empirical studies support the hypothesis that land ownership encourages adoption of water saving technologies, but there are studies that report results contradicting this hypothesis. Bultena and Hoiberg (1983) found no support for the hypothesis that land tenure has a significant influence on adoption of conservation tillage. Farmer experience is the final demographic variable in the model. Years of experience can lead to greater understanding of the production process; it can also establish social networks, which enable higher farmer awareness of available technology in the agricultural sector. Experience has the potential of enhancing farmer productivity (Kalirajan & Shand, 1985), and social networks affect productivity as well as adoption of technology (Birkhaeuser et al., 1991). We include these variables as important factors influencing irrigation decisions. Interaction terms between UCCE and farmer age are also included in our econometric model, to test the hypothesis that older farmers are less likely to adopt new knowledge and technology imparted by UCCE.

The econometric models we estimate for equations 1 and 2 are the following:

$$P_{it} = \alpha_1 + \beta_1 A_{it} + \beta_2 I_{it} + \beta_3 C_{it} + \beta_4 U_{it} + \beta_5 O_{it} + \beta_6 D_{it} + \beta_7 (UCCE_{it} * Age_{it}) + \gamma\theta_j + \delta\lambda_t + \varepsilon_{it} \quad (3)$$

$$V_{it} = \alpha_2 + \rho_1 A_{it} + \rho_2 I_{it} + \rho_3 C_{it} + \rho_4 U_{it} + \rho_5 O_{it} + \rho_6 D_{it} + \rho_7 (UCCE_{it} * Age_{it}) + \gamma\psi_j + \delta\varphi_t + \varepsilon_{it} \quad (4)$$

where all variables are defined above. We also include county *j* and year *t* fixed effects to control for common factors across counties and common conditions between the two years under consideration (2003 and 2008) in the analysis. We consider clustered standard errors $\varepsilon_{it}$ at the county level because our climate variables vary at the same level of aggregation.[5]

## 2.2 DATA AND VARIABLES

### 2.2.1 Farm and Ranch Irrigation (FRIS) data

For the empirical analysis, we use the Farm and Ranch Irrigation Survey (FRIS) for information on farm level irrigation methods, water application from different on-farm and off-farm sources, acres irrigated and harvested for each crop, irrigation costs, sources of information on irrigation methodologies, and farmer demographics. This survey was introduced as a complimentary study to the Agricultural Census by USDA in order to obtain further information on farmers' irrigation decisions based on their location, available water sources, and available irrigation options and costs. FRIS was first implemented in 1979 and it is carried out on a five-year basis, usually in the year following the Agricultural Census. The survey is sent out to a sample of farmers who indicate on the Agricultural Census survey that they used irrigation on their farm. FRIS data is published at the aggregated state level; we obtained farm-level data for our analysis, from the USDA-NASS Pacific headquarters in Sacramento.

A survey question to identify the farmer's source of irrigation information was introduced. To answer the question, farmers are provided with various options, one of which is "extension agents or university specialists"; we use this indicator variable to represent the presence and influence of cooperative extension (UCCE), our independent variable of interest. For the empirical analysis, we use farm-level FRIS data for the years 2003 and 2008, which include data on irrigation practices as well as farm and farmer demographics.[6] The data set represents a repeated cross section of farmers in California, for the two census years.

The survey contains information on average crop yields per irrigated acre for a group of field and vegetable crops, including corn (all types, including grain or seed, and silage or green chop), sorghum, wheat (grain or seed), barley (grain or seed), beans (dry, edible), rice, alfalfa and alfalfa mixtures, hay, sugar beets, cotton, and vegetables such as potatoes, lettuce, tomatoes, and sweet corn. However, it excludes this information on all berries, fruits and nuts, and pastureland production per irrigated acre, which therefore excludes these crops from the first part of our analysis. Hence, our value of agricultural output includes field crops and vegetables only.[7] The issue of aggregating outputs of a variety of crops measured in different units has been addressed by multiplying each crop yield with the corresponding price per unit of crop output. The data on crop prices has been obtained from the 2003 California Agricultural Statistics,[8] published by the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). The average crop output per irrigated acre for both years 2003 and 2008 were multiplied by the 2003 prices to obtain the inflation-adjusted dollar amount of average value of agricultural output per irrigated acre — the dependent variable of interest in equation (3). Figure 1 presents the distribution of the values in our sample of 1953 (farm) observations. Fifty-five percent of the farmers report average value of output per acre of irrigated land within the range of $0–$500, 11 percent within the range $500–$1,000, 11 percent within the range $1,000–$2,000, and 9 percent in $20,000–$40,000. Only 0.6 percent farmers are in the range of $40,000–$70,000, which is the highest range in our sample.

FRIS includes information on volume of water used for irrigation from all on-farm and off-farm sources, measured in acre-feet. The aggregated volume of irrigation water is divided by number of irrigated acres to obtain our dependent variable for estimating equation (4), water use per irrigated acre. Distribution of the values of volume of water per irrigated acre is presented in Figure 2. Twenty-nine percent of the sample stays within the range of 0–1 acre-foot/acre, followed by 27 percent in the range of 2–3 acre-feet/acre. The highest range in our sample is 11-12 acre-feet/acre, which includes only two observations.[9]

UCCE is included as one of nine sources for irrigation information in the FRIS dataset. Figure 3 reports the number of farmers who choose each of the different sources for information on irrigation. The most popular (35 percent) source of irrigation information, as indicated by farmers, is neighboring farmers, followed by nearly 33 percent of the farmers indicating UCCE as a source of irrigation information and 27 percent indicating hired private irrigation specialists or commercial crop consultants as their source of information.[10]

We include three irrigation systems from the survey data: (1) gravity, (2) sprinkler, and (3) drip, trickle and sub-irrigation systems. Farmers in the dataset either exclusively use a single system, or some combination of the available irrigation systems. Nearly 31 percent, 7 percent, and 12 percent indicate gravity, sprinkler, or drip, trickle and sub-irrigation, respectively, as the only irrigation system on their operation, and 7 percent indicate some combination of all three systems.

Information on cost of off-farm water, and average well depth is recorded for each farm in the FRIS data set.[12] Higher cost of off-farm water is indicative of scarcity of water, as is high well-depth values. Off-farm water cost has been converted to constant 2003 US dollars for the analysis and divided by number of irrigated acres reported. For the construction of the variable representing well depth, we calculated the mean depth (feet) of the three major wells, which were reported for irrigation purposes by the farm.

Irrigation water is used as crop freeze and heat mitigation mechanisms in California's agriculture. Freeze damage to vegetable and fruit crops leads to loss of output (Carman & Sexton, 2007), and therefore, mitigation mechanisms are employed to minimize the loss. Harsh weather conditions, and low precipitation rates in agriculturally important regions, such as the San Joaquin and Imperial Valleys, need control and mitigation mechanisms, which have bearing on farmers' irrigation decision. We include indicator variables representing the farmer's usage of irrigation water for each mechanism as indicators of weather conditions (Olen et al., 2015). For our sample, 13 percent of the farmers report using irrigation water for freeze control and mitigation measures, and 7 percent for heat mitigation and crop cooling measures.

FRIS includes data on farmer's crop choice, average output per irrigated acre, and irrigated acres harvested for all crops grown on the farm. Farmer's crop choice is an indicator of suitability of the crop to the soil type. We use the data on irrigated acres harvested to create indicator variables representing types of crops grown on the farm. We generate these variables for a number of crop types, including all fruit and nut crops, vegetables, corn, wheat, alfalfa, hay, and pasture. Thirty-eight percent of the farmers indicate harvesting fruit and nut crops, followed by 29, 21, 19, 17, 14, and 9 percent indicating harvesting alfalfa, vegetables, wheat, corn, hay, and pasture, respectively. Soil salinity is another indicator for soil quality, and remains an important issue in California's agriculture, especially in the San Joaquin Valley and Imperial Valley regions (Letey, 2000). Using irrigation water for leaching the soil of salts is common practice, and likely impacts farmers' irrigation decision. Six percent of the farmers report using irrigation water for salinity control. We use a dichotomous variable representing usage of irrigation water for leaching (salinity control) as an indicator of soil quality of the farm.

Farmer demographic variables included in the model are farmer age, tenure type (whether primary occupation of the operator is farming), type of operation represented by whether the principal manager of the operation is a hired manager, and experience. Figure 4 presents the age distribution of farmers in the sample with a mean of 57 years. Nearly 86 percent of farmers report themselves as "farm or ranch operators," and 18 percent report the principal manager as the hired manager of the operation. Mean farming experience is 25 years.

Table 1 reports the summary statistics and description of the variables included in the empirical analysis.[12] On average, nearly 2 acre-feet of water is applied per irrigated acre in our sample. Mean value for the variable representing average output per irrigated acre is nearly $4,100.[13] Mean off-farm water cost amounts to $39 per acre-foot. Mean well depth is 63 feet. The average precipitation and temperature values are 1.3 inches and 62 degrees Fahrenheit, respectively.

### 2.2.2. National Oceanic Atmospheric Administration (NOAA) Data on Precipitation and Temperature

Data on average monthly precipitation and temperature for our study are collected from NOAA, for all active weather stations in California that are geo referenced. These data are used to create annual averages for each weather station. Then, these stations are matched to the counties in our sample following Burgess et al. (2011). County level weighted annual average temperature and precipitation variables are generated using a weighted average formula; the weights are the inverse of the distance between a station and centroid of a county, for all stations within 50 miles of the centroid.[14]

### 2.2.3. Data Limitations

The data that we use were made available to us on ad hoc arrangements for a limited period of research and analysis. The FRIS data set is a repeated cross sample, and we were able to use the years 2003 and 2008. Several caveats are mentioned. Farmer endogeneity is known in repeated farm level cross sectional data. We were limited in using appropriate control variables to reduce unobserved factors, which may affect our dependent variable. Our climate data are at the county level. To match between the production data and the climate data we had to calculate per acre values for the production data at the county level and county climate measures.

## 3. EMPIRICAL RESULTS

### 3.1. Farmer age and UCCE information adoption, and the combined impact on irrigated agriculture production and water use per irrigated acre

To realize the impact of UCCE, we have to identify which group of farmers utilizes the irrigation information, and how this information, in turn, affects their irrigation water use. For this, we break the data into two groups — the first consisting of those who report UCCE as a source of irrigation information, and the second of those who report UCCE as not their source. For each of the two groups, we calculate the mean of the dependent variables, for each age level in our sample. We do this for both average value of output per irrigated acre and volume of water applied per irrigated acre. Figures 5 and 6 report the results, respectively.

In Figure 5, we observe that on average, farmers of all ages who report UCCE as a source of irrigation information have a higher average value of output per irrigated acre. The gap between users and non-users of UCCE information is higher for younger farmers, gradually diminishing for older farmers, and finally converges for the oldest farmers in the sample (probably capturing also the experience effect). Average value of output per irrigated acre is a diminishing function of age according to the data, much like the empirical results reported by Tauer (1995). According to that study, farmer productivity generally increases, and then decreases with age; farmers of different ages display different productivities in utilizing the existing technology. We also observe similar trends in Figure 5; the output per irrigated acre values for age groups 17–40 years are lower on average, for both users and non-users of UCCE information. For age groups 45–65, the values increase, and then around 70 years they start declining.

In Figure 6, we observe that farmers of all ages who report use of UCCE information use on average more irrigation water per irrigated acre than the reported non-users. The gap between users and non-users is lower for older producers (capturing also the impact of experience). Compared with non-users of UCCE information, users employ nearly an additional 1 acre-foot per irrigated acre. Crop-specific water requirements can be a possible reason behind this phenomenon. From the data, we observe that 17 percent of farmers who use UCCE information harvest fruit and nut crops, field crops, and vegetables; 33 percent harvest vegetables as well as field crops, and 9 percent use their land as pastureland. Because field crops in general have higher water requirement, the higher percentage of farmers who harvest them can raise the average water usage for all age groups.

Scrutiny of the 95 percent confidence intervals for the fitted values in Figure 5 and Figure 6 could be useful. There is an overlap of the 95 percent confidence interval for value of agricultural output per irrigated acre for the "with" and "without" UCCE information. This implies that UCCE information has an impact on the value of agricultural output per irrigated acre on average, but there is no differential impact (slope very similar between the two groups) of UCCE's information by age. There is no overlap of the 95 percent confidence interval for the "with" and "without UCCE information" groups. This implies that UCCE information has a statistically significant impact on the volume of water applied (acre-feet) per irrigated acre on an average, but there seems to be no differential impact (slope very similar for the two groups) of UCCE's information by age. These findings are very important for extension policy and outreach programs and will be discussed in the Conclusion and Policy Implication section.

By controlling for crop types we can introduce the selection of crop mix and its effect on water use; this allows us to estimate the impact of UCCE on irrigated agriculture production and water use per irrigated acre.

## 3.2. Impact of UCCE irrigation information on irrigated agriculture productivity

Table 2 reports the regression coefficients of the model in equation (3), where the dependent variable is the average value of output per irrigated acre. Coefficients of specific variables are interpreted while holding all other values constant. UCCE information U, on irrigation has a positive, statistically significant impact of $3,035 on average value of output per irrigated acre. This increment amounts to 74 percent of the mean for the sample. With increasing farmer age, UCCE knowledge has a significant negative impact of $53.22 per year of farmer's age. This result hints toward age-related difference in the degree of implementation of available knowledge, as Tauer (1995) and Tauer and Lordkipanidze (2000) suggest, such as differences in implementation of the prescribed methods.

We do not observe any significant impact of off-farm surface water availability (Variable *A*) represented by cost per irrigated acre or by well depth, on farm productivity per acre. This finding, while initially unexpected, could mean that farmers are able to adapt to higher water scarcity levels by using advice of UCCE, such as moving to higher value, less water-thirsty crops.

We do not observe positive coefficient for any of the standalone irrigation systems.[15] Sprinkler as a standalone irrigation system has a significant negative impact of $1,864 on farm level irrigated agriculture production, whereas a combination of all three systems has a significant positive impact of $3,091. Sprinkler system may be associated with water wastage caused by evaporation in regions of high temperatures, which raises water cost. The high, statistically significant positive impact of the combination of all systems has important implications. This implies that a combination of all irrigation systems is beneficial for irrigated agriculture productivity, enhancing farm level average value of output per irrigated acre. This finding is also in line with irrigation practices, where different irrigation systems are employed in different periods of the growing cycle (for field crops for example): sprinklers during pre-season, and prior to planting, if needed, and drip during the entire irrigation season.

Significant climate-related variables (variables *C*) are those for frost and heat control. Channeling irrigation water to deal with frost damage has a negative impact of nearly $965. Although this seems counterintuitive, frost mitigation measures could have been responsible for diminishing an even bigger loss for farmers.[16] On the other hand, irrigation water usage for heat mitigation adds a statistically significant positive amount of $1,563 to average value of output per irrigated acre. Both weighted mean temperature and precipitation have positive impacts, but the coefficients are not significantly different from zero. The quadratic terms are not significant as well. In the category of farmland characteristics (variables *O*), vegetables, corn and hay production have positive significant coefficients of $15,906, $1,362 and $569, respectively. Farmer demographic variables (*D*), are not statistically significant. The sign for farmer age is negative, which supports the results in Figure 5. The interaction between UCCE and farmer's age is negative and significant for the higher range of the age group. Tenure characteristics such as principal occupation, hired manager, and experience on the farm do not affect irrigation efficient productivity significantly.

## 3.3. Impact of UCCE on irrigation water use per irrigated acre

Table 3 reports the regression coefficients for the model (equation 4) with volume of water applied per irrigated acre (acre-feet/acre) as the dependent variable. Coefficients of specific variables are interpreted while holding all other values constant. We observe that UCCE information has a positive significant impact of 1.17 acre-feet/irrigated acre on irrigation water use. This impact of UCCE amounts to nearly 50 percent of the mean water use per irrigated acre for the sample. With increasing farmer age, UCCE irrigation information has a significant negative impact of 0.01 acre-feet/acre. This implies that older farmers who are users of UCCE information tend to apply less water per irrigated acre. This may be the result of such farmers growing less profitable crops, which are characterized by lower water consumption per acre. Among water availability variables (A), off-farm water cost per irrigated acre has no statistically significant impact on water use per irrigated acre. This could be explained by the fact that the marginal productivity of water is much higher than the cost of water, which we already know as a fact in California. This result could also indicate that surface water is considered as a quantity rationed input, and therefore, marginal changes in price do not lead to alteration of farmer irrigation decisions or conservation, as reported by Moore and Dinar (1995). Average well depth has a small, significant positive effect of 0.006 acre-feet/irrigated acre on water usage.[17]

We observe a significant negative coefficient of 1.04e-05 acre-feet/irrigated acre for the quadratic term for average well depth, indicating decreasing marginal impacts of that variable. Therefore, rising well depth discourages water pumping but does not affect average output per irrigated acre. Standalone irrigation systems all have significant impacts on water use/per irrigated acre. Gravity system leads with the highest positive impact on water use, at 1.33 acre-feet/irrigated acre, followed by sprinkler at 0.46 acre-feet/irrigated acre, and drip, trickle, and sub-irrigation at 0.38 acre-feet/irrigated acre.

These results are expected because gravity system is known to be the most water-intensive irrigation system and leads with the highest water usage among all three systems. According to our results, sprinkler systems lead with more irrigation water use compared to drip, trickle, and sub-irrigation systems. The additional water usage could be the result from loss of water via evaporation from the plant surface. A combination of all three irrigation systems does not have any significant impact on water usage/irrigated acre. Therefore, our results imply that not only does the combination of irrigation systems have no significant incremental impact on water use per irrigated acre, but it also has a positive impact on irrigated agriculture productivity. This may have important implications in terms of policy decisions.

Among climate variables, *C*, mean temperature and precipitation do not have statistically significant coefficients.[18] We find a positive significant coefficient of 0.24 acre-feet/irrigated acre, for irrigation water used for frost mitigation. Fruit and nut crops, alfalfa, vegetables, pasture, and hay have significant positive increase on water use/irrigated acre of 0.75, 0.63, 0.65, 0.43, and 0.44 acre-feet/irrigated acre, respectively.

We observe a reduction in water usage/irrigated acre with increasing farmer age, when farmers indicate UCCE as the source of irrigation information. To capture the impact of farmer age on water usage, we divided the farmer ages into groups, which are: less than 40, 40–50, 50–60, 60–70, 70–80, and above 80. We interact the dummy variable representing the age group to which each observation belongs, with the dummy variable representing UCCE as the information source. We estimate the same model as before (Equation 4), but with the addition of all age groups, keeping the first age group as the benchmark and all interaction terms except the first.[19] According to the regression results reported in Table 4, farmers younger than 40 who indicate UCCE as a source of irrigation information have a significant positive rise in water use, amounting to 0.61 acre-feet/irrigated acre. In comparison to the reference group (users of UCCE information in the age group of less than 40 years), we observe that for age group 70–80, UCCE users have a significant negative impact on water use of

0.78 acre-feet/irrigated acre,[20] and for the age group of 70–80 age group, this negative impact amounts to 0.75 acre-feet/irrigated acre. Therefore, UCCE irrigation information has a significant positive impact on water use for farmers less than 40 years of age, and a significant negative impact on water use for farmer ages of 70 and above. These results imply that older farmers who are users of UCCE information use less water than younger users, which is opposite to the results reported by Dinar and Yaron (1990). Other coefficients reported in Table 4 are comparable with those reported in Table 3.

Using the average cost of irrigation water per acre-feet across the two census years, the cost of the additional 1.17 acre-feet amounts to approximately $40. This means that value of production to farmers who use UCCE irrigation information amounts to approximately $2,995 per irrigated acre.[21]

The results indicate that UCCE's irrigation information leads to higher farmer irrigation water use, on average. This goes against the perception that irrigation-efficient technology leads to water savings. UCCE advocates the use of irrigation-efficient technology such as drip irrigation systems, which save water and produce more output (Taylor et al., 2014; and Peterson & Ding, 2005). A plausible reason for irrigation-efficient technology accompanied by increase in water use is suggested by Huffaker and Whittlesey (2003), and Scheierling, et al. (2006), explaining the coefficient estimates reported in Table 3 and Table 4. With the investments in irrigation-efficient technology suggested by UCCE, farmers save irrigation water. Given that land is still available, they increase their irrigated acreage and use this saved water to attain maximum yield; this higher yield leads to higher demand for water, which is met by increase in water application. Dinar and Zilberman (1991) coined this increase in irrigated land and water use as "expansion effect." As Ward and Pulido-Velazquez (2008) suggest, irrigation water-saving technology solutions lead to increase in crop production; but the greater yield leads to increase in evapotranspiration (ET), which ultimately leads to higher water consumption and overall depletion, in the presence of return flows. In the absence of return flows, water use increases by the amount of applied water use from both on- and off-farm sources, to maintain the higher yield. Therefore, our results suggest that UCCE's irrigation information does not lead to overall reduction in water use through water-saving irrigation systems. However, through the use of the water-saving irrigation systems, farmers do increase the average value of output per irrigated acre, with the increased irrigation water use.

## 3.4. Impact of the combination of UCCE and other sources of irrigation information

While UCCE as the major source of irrigation information has a significant impact on irrigated agriculture production and water use per irrigated acre, there are other sources of irrigation information indicated in the survey that may have a significant impact as well. We infer whether or not obtaining knowledge from at least one additional source (Figure 3) besides UCCE is better on the margin than obtaining it from a single source. For this purpose, we created a variable that indicates whether the farmer obtained irrigation information from at least one out of the eight other sources of irrigation information mentioned on the survey. We incorporate the interaction term between this variable and our dummy variable indicating UCCE as a source of irrigation information into our original regression equations (3 and 4). Remaining variables are kept unchanged in the new models. The regression results are reported in Tables 5 and 6.

In Table 5, we observe a statistically significant positive impact of the information source combination on irrigated agriculture production, amounting to $2,813 per irrigated acre. This amount is lower than the impact we observe for only UCCE in Table 2, hinting at a reduced impact of the combination of irrigation information sources. Other coefficients are similar to those in Table 2: increase in farmer age and the irrigation information source combination has a significant negative impact of $51; sprinkler system as the standalone irrigation system has a significant negative impact of $1,854, combination of all three irrigation systems has a significant impact of $3,100. Irrigation water use for frost mitigation has a significant negative impact of $944, and heat mitigation has a significant positive impact of $1,586; vegetable production has a significant positive impact of $15,913, corn $1,370, and hay $574 per irrigated acre.

From the results in Table 2 and Table 5, we test whether the difference in the impact between having only UCCE as the source of irrigation information and a combination of sources is significant or not. This has policy implications because of the expenditures involved in the provision of irrigation information from these other sources. These expenditures are incurred by the government as well as the individual farmers. Our t-test results indicate that this difference in coefficients across the two models is not significantly different from zero.[22] This result implies that the additional source of information does not make any significant change to irrigated agriculture productivity. This could be because of the fact that some of the information provided by other sources may be borrowed from the free and publicly available information disseminated by UCCE.

Regression results for water use/irrigated acre as the dependent variable are reported in Table 6. We observe a positive, significant coefficient for the information source combination on water use, which amounts to 1.03 acre-feet/irrigated acre. This impact on water use is lower than that obtained for only UCCE as the source of irrigation information, as indicated in Table 3. The results of the t-test indicate that the difference between the coefficients obtained in Table 3 and Table 6 is statistically insignificant. Therefore, obtaining knowledge from UCCE and at least one other source of irrigation information does not significantly change the impact of the information on irrigation water use.

## 4. CONCLUSION AND POLICY IMPLICATIONS

We estimate the impact of UCCE on irrigated agriculture production (inflation-adjusted value of average output per irrigated acre), and water use, represented by volume of water applied per irrigated acre. Results indicate that UCCE as a source of irrigation information has significant positive impact on irrigation productivity as well as water use per irrigated acre. Taking into consideration this increase in irrigation water use, the net increase in productivity goes up by approximately $2,095 per irrigated acre. Our results suggest that irrigation-efficient systems advocated by UCCE may be counterproductive in terms of overall irrigation water use. However, UCCE's irrigation information does lead to rise in output, and hence farmer revenue (which doesn't necessarily mean increase in profit). In terms of policy interventions regarding reduction of water use, research projects aimed at improving the understanding of the hydrological system of river basins can be commissioned; irrigation-efficient technology can be more effective with more comprehensive understanding of issues such as return flows and aquifer recharge rates. As Ward and Pulido-Velazquez (2008) point out, allocating water rights based on water depletion and not water use, reducing evaporation from soil or supply sources, restricting acreage and water application expansion in cropped areas, and deficit irrigation can lead to real water savings. Another pertinent issue is the difference between water applied and water consumed; the water applied may not be consumed by crops in its entirety, and typically returns to the river as runoff or to the underlying aquifer through deep percolation (Hartmann & Seastone, 1965). Therefore, changes in water applied because of irrigation-efficient technologies may not accurately capture water saved. Better understanding of underlying hydrological system, economic systems such as water and other input prices, water rights, crop mix, and farmer demographics, can lead to water savings and productivity rise from irrigation-efficient practices and technologies, recommended by UCCE.

Joint effect of UCCE and other sources of irrigation information are also estimated and have important policy implications. We observe that the combination of UCCE and at least one other source of irrigation information does not lead to any significant change in the impact on irrigated agriculture production or water use per irrigated acre. This does not necessarily mean that other irrigation information sources are not important. This is because other sources of information may borrow the information that is already made available by UCCE. Therefore, other sources of irrigation information can play the role of substitutes in dissemination of knowledge, through greater collaboration with UCCE. This could reduce UCCE costs of outreach.

Because of unavailability of data for all variables in our model, we are unable to estimate the impact of UCCE on value of output per irrigated acre per unit of water. This is a possible direction for future work to improve our understanding of farmer decisions regarding water use and irrigation-water use efficiency, for policy perspective.

Several caveats need to be discussed. Farmer endogeneity is a relevant issue in case of repeated farm level cross sectional data. We have included as many relevant control variables as possible in the empirical analysis, to reduce unobserved factors, which may affect our dependent variable. However, one can still argue the existence of unobservable factors, which may lead to overestimation (or underestimation) of the coefficients in our model, and especially that of UCCE. More detailed data can address this issue of endogeneity better. Another issue we have not dealt with in this paper is the improvement of efficiency of other agricultural inputs, made possible through UCCE's research and information dissemination. Future research could address this issue through the incorporation of interactions of inputs and UCCE's irrigation information availability in the empirical analysis.

More studies on this topic can improve our understanding of how UCCE information can improve water use efficiency and enhance productivity. Better understanding of the demographic characteristics and efficiency level of the users of UCCE knowledge can help in designing more targeted outreach programs, both for users and non-users; this can increase the effectiveness of the programs and improve adoption of UCCE prescribed technology among farmers. Special programs can be designed, which will target older farmers, to enhance irrigation-efficient productivity. Based on our results, collaboration among UCCE and other private and government sources of irrigation information can potentially reduce water use; creation and improvement of networks of collaboration can potentially lead to reduction in irrigation water use, with higher irrigated agriculture production.

## APPENDIX

The FRIS surveys a sample of farmers surveyed in the Agricultural Census. The website states that chances of larger farms being sampled for the FRIS is higher. We can observe that county average farm size in our FRIS sample is higher than that reported by the Census a year earlier, for both the FRIS years 2003 and 2008. Therefore, based on our coefficient estimates, it seems that our results could be specific to farmers owning bigger sized farms, for 2003 and 2008. Because the FRIS is the most comprehensive national level survey, it is the best data that is publicly available for empirical analysis. Given the scope of this data set, we cannot reject the issue of endogeneity rising from selection of bigger farms. Bigger farmers could be driven by the profit motive rather than the conservation motive, especially in the pre-drought years of 2003 and 2008. Extending our analysis to a longer repeated cross section could provide us more accurate answers on the issue of the impact of UCCE on water use efficiency.

## ENDNOTES

1. All county offices have their own irrigation programs. Some examples include Monterey, Fresno, and Tehama, the links to which are provided below.

   http://cemonterey.ucanr.edu/Custom_Program567/

   http://ucanr.edu/sites/irrigation_and_soils_/

   http://cetehama.ucanr.edu/Water___Irrigation_Program/

2. http://wwwcimis.water.ca.gov/cimis/welcome.jsp

3. We use value of agricultural sales to measure agricultural productivity in this paper. Although these two terms are not the same because we do not account for cost of production. Value of agricultural sales is used in this analysis as a proxy of the county's agricultural sector productivity, following a similar methodology by OECD (2001).

4. Leaching the soil of salts is important in the Central Valley and may not necessarily be used everywhere in California.

5. On its face location and climate (temperature and precipitation) are expected to be highly collinear. However, given the similarity in climate across many of the agricultural areas in the 50 counties, and given the fact the county fixed effects control for many other variables, the correlation between county fixed effects and climate was relatively low at 0.18 and 0.22 for temperature and precipitation, respectively.

6. We obtained data for all FRIS years except 1979; but we were unable to use all censuses since 1994, which include the question to identify farmers' source of irrigation information. This is because the FRIS data set for some years did not include farmer demographic variables.

7. The exclusion of fruit and nut crops from the analysis is a caveat of this paper, given the importance of these crops in California's agricultural receipts. Therefore, our coefficients should be seen as a lower estimate of the UCCE contribution to the agricultural sector of the state of California.

8. https://www.nass.usda.gov/Statistics_by_State/California/Publications/California_Ag_Statistics/Reports/2003casall.pdf.

9. Crops for which reported irrigation water usage is above 10 acre-ft. per irrigated acre include field crops such as alfalfa, hay, wheat, pasture, and vegetable crops.

10. The survey does not include information on whether UCCE was the main source of information for a farmer. Therefore, there could be some overestimation of the impact of UCCE. However, throughout interactions with UCCE officials it was revealed that UCCE's publicly available information is used by other private agents, which reduces the possibility of a very large overestimation of the coefficient of UCCE in our analysis.

11. There is no information in FRIS on the quantity of riparian water rights that farmers are using.

12. The data set consists of 1953 observations for all variables except farmer age and experience, which have 36 missing observations. The summary statistics for each variable are calculated for all observations in the data set.

13. The mean value of average agricultural output per irrigated acre is about four times that for the values in the agricultural census. There could be two possible explanations for this: a) irrigated acres are less than total acres, which reduces the value of the ratio of output to acreage, and b) according to USDA, FRIS has a higher chance of sampling the bigger farmers with higher output per irrigated acre.

14. NOAA data do not include information on growing degree days for California counties, which is why we have used the following temperature and precipitation values, based on the literature.

15. All coefficient estimates for the I variables are to be interpreted as comparisons to two baseline cases of "no irrigation system" and "combination of two irrigation systems."

16. This implies that the negative regression coefficient is not because frost mitigation measures lead to a fall in the output; but the negative correlation is due to frost damage of an even bigger magnitude, which may have been partially reduced by the use of frost mitigation measures.

17. There could be possible endogeneity associated with the variables because of the fact that richer farmers can dig deeper wells. With the availability of more detailed data on farmer income, this issue may be addressed. (See Appendix)

18. The signs for precipitation, temperature, and their square terms are intuitive; those for precipitation indicate that water use will be reduced with increasing precipitation, and the rate of reduction of water use decreases with higher precipitation. For temperature, increase will gradually lead to a rise in water use, which will change the coefficient from negative to a positive.

19. The first group (less than age 40) is the reference group here. Its coefficient is represented by the coefficient of "UCCE" in Table 4.

20. We add the coefficient of the reference group represented by first row of Table 4 to the coefficient for "UCCE*(70–80)" and "UCCE*(80 above)" age groups to obtain the total impact.

21. We use the average cost of irrigation water from the Farm and Ranch Irrigation Survey, for the years 2003 and 2008. We express the 2008 value in constant 2003 USD, and then obtain the mean across the two years.

22. We use the "suest" command in Stata to test whether the difference in the coefficients from the two models equals zero. Based on the value of the chi-squared statistic and the P-value, we cannot reject the null hypothesis that the difference equals zero.

## REFERENCES


Adams, R., J. Wu, and L.L. Houston. 2001. "Changes in crop yields and irrigation demand." *The Impact of Climate Change on Regional Systems: A Comprehensive Analysis of California:* 1451–1460.

Allen-Diaz B. 2009. "Climate change affects us all." California Agriculture 63(2):51–53.

Bates, B.C., Z.W. Kundzewicz, S. Wu, and J.P. Palutikof, (eds) 2008. "Climate Change and Water." Technical Paper of the Intergovernmental Panel on Climate Change. Geneva: IPCC Secretariat.

Birkhaeuser, D., R. Evenson, and G. Feder. 1991. "The economic impact of agricultural extension: A review." *Economic Development and Cultural Change* 39 (3):507–521.

Bultena, G.L., and E.O. Hoiberg. 1983. "Factors affecting farmers' adoption of conservation tillage." Journal of Soil and Water Conservation 38(3):281–284.

Burgess, R., O. Deschenes, D. Donaldson, and M. Greenstone, 2011. "Weather and death in India." Cambridge, United States: Massachusetts Institute of Technology, Department of Economics. Manuscript.

Carman, H., and R.J. Sexton. 2007. "The 2007 Freeze: Tallying the toll two months later." *ARE Update* 10(4):5–8.

Caswell, M., and D. Zilberman. 1985. "The choices of irrigation technologies in California." *American Journal of Agricultural Economics* 67(2):224–234.

Caswell, M.F., and D. Zilberman. 1986. "The effects of well depth and land quality on the choice of irrigation technology." *American Journal of Agricultural Economics* 68(4):798–811.

Chatterjee, D., A. Dinar, and G. González-Rivera, 2018. "An Empirical Knowledge Production Function of Agricultural Research and Extension: The Case of the University of California Cooperative Extension." *Technological Forecasting and Social Change* 134:290–297.

Datt, G., and M. Ravallion. 1998. "Farm productivity and rural poverty in India." *The Journal of Development Studies* 34(4):62–85.

Dinar, A., and D. Yaron. 1990. "Influence of quality and scarcity of inputs on the adoption of modern irrigation technologies." *Western Journal of Agricultural Economics*: 224–233.

Dinar, A., and D. Zilberman. 1991. "The economics of resource-conservation, pollution-reduction technology selection: The case of irrigation water." *Resources and Energy Economics* 13:323–348.

Grewal, J.S., and S.N. Singh. 1980. "Effect of potassium nutrition on frost damage and yield of potato plants on alluvial soils of the Punjab (India)." *Plant and Soil* 57(1):105–110.

Guiteras, R. 2009. "The impact of climate change on Indian agriculture." Manuscript, Department of Economics, University of Maryland, College Park, Maryland.

Hartman, L.M., and D.A. Seastone. 1965. "Efficiency criteria for market transfers of water." *Water Resources Research* 1(2):165–171.

Hatfield, J.L., and J.H. Prueger. 2015. "Temperature extremes: Effect on plant growth and development." *Weather and Climate Extremes* 10:4–10.

Huffaker, R., and N. Whittlesey. 2003. "A theoretical analysis of economic incentive policies encouraging agricultural water conservation." *International Journal of Water Resources Development* 19(1):37–53.

Hayden-Smith, R., and R. Surls. 2014. "A century of science and service." *California Agriculture* 68(1):8–15.

Kalirajan, K.P., and R.T. Shand. 1985. "Types of education and agricultural productivity: A quantitative analysis of Tamil Nadu rice farming." *The Journal of Development Studies* 21(2):232–243.

Letey, J. 2000. "Soil salinity poses challenges for sustainable agriculture and wildlife." *California Agriculture* 54(2):43–48.

Li, W., Z. Wei, Z. Qiao, Z. Wu, L. Cheng, and Y. Wang. 2013. "Proteomics analysis of alfalfa response to heat stress." *PLOS One*, 8(12):p.e82725.

Lobell, D.B., C.B. Field, K.N. Cahill, and C. Bonfils. 2006. "Impacts of future climate change on California perennial crop yields: Model projections with climate and crop uncertainties." *Agricultural and Forest Meteorology* 141(2):208–218.

Masmoudi, M.M., K. Nagaz, and N.B. Mechlia. 2010. "Perception of drought by farmers and its impact on farming and irrigation practices." *Options Méditerranéennes* 95:323–327.

Moore, M.R., and A. Dinar. 1995. "Water and land as quantity-rationed inputs in California agriculture: Empirical tests and water policy implications." *Land Economics*. Pp.445–461.

Negri, D.H., and D.H. Brooks. 1990. "Determinants of irrigation technology choice." *Western Journal of Agricultural Economics*. Pp. 213–223.

OECD (Organization for Economic Co-Operation and Development) (2001). Measuring Productivity: Measurement of Aggregate and Industry-Level Productivity Growth, OECD Manual. Paris, OECD. Retrieved on December 2018 at https://www.oecd.org/std/productivity-stats/2352458.pdf.

Olen, B., J. Wu, and C. Langpap. 2015. "Irrigation decisions for major West Coast crops: Water scarcity and climatic determinants." *American Journal of Agricultural Economics* p.aav036.

Parker, D.D., and D. Zilberman. 1996. "The use of information services: The case of CIMIS." Agribusiness 12(3):209–218.

Parker, D., D. Cohen-Vogel, D. Osgood, and D. Zilberman. 2000. "Publicly funded weather database benefits users statewide." *California Agriculture* 54(3):21–25.

Parry, M.L., C. Rosenzweig, A. Iglesias, M. Livermore, and G. Fischer. 2004. "Effects of climate change on global food production under SRES emissions and socio-economic scenarios." *Global Environmental Change* 14(1):53–67.

Peterson, J.M., and Y. Ding. 2005. "Economic adjustments to groundwater depletion in the high plains: Do water-saving irrigation systems save water?" *American Journal of Agricultural Economics* 87(1):147–159.

Rasmussen, W. D. 1989. *Taking the university to the people. Seventy- five years of cooperative extension.* Iowa State University Press, Ames, IA.

Scheierling, S.M., R.A. Young, and G.E. Cardon. 2006. "Public subsidies for water-conserving irrigation investments: Hydrologic, agronomic, and economic assessment." *Water Resources Research*, 42(3).

Schuck, E.C., and G.P. Green. 2001. "Field attributes, water pricing, and irrigation technology adoption." *Journal of Soil and Water Conservation* 56(4):293–298.

Southworth, J., J.C. Randolph, M. Habeck, O.C. Doering, R.A. Pfeifer, D.G. Rao, and J.J. Johnston. 2000. "Consequences of future climate change and changing climate variability on maize yields in the midwestern United States." *Agriculture, Ecosystems & Environment* 82(1):139–158.

Tauer, L. 1995. "Age and farmer productivity." *Review of Agricultural Economics*. Pp. 63–69.

Tauer, L.W., and N. Lordkipanidze. 2000. "Farmer efficiency and technology use with age." *Agricultural and Resource Economics Review* 29(1):24–31.

Taylor, R., D. Parker, and D. Zilberman. 2014. "Contribution of University of California Cooperative Extension to Drip Irrigation." *ARE Update* 18(2):5¬–8. University of California, Giannini Foundation of Agricultural Economics.

Ward, F.A., and M. Pulido-Velazquez. 2008. "Water conservation in irrigation can increase water use." *Proceedings of the National Academy of Sciences*, 105(47):18215–18220.

**Table 1. Variable description and summary statistics**

| Variable | Mean | Standard Deviation | Minimum | Maximum | Description |
|---|---|---|---|---|---|
| Average value of output per irrigated acre | 4094.83 | 9383.69 | 0 | 60449.1 | Inflation-adjusted $ value of average crop output per irrigated acre ($/acre) |
| Applied water per irrigated acre | 2.35 | 1.84 | 0 | 11.97 | Volume of water applied from all sources (acre-foot), per irrigated acre of farm land (acre-ft./acre) |
| UCCE | 0.33 | 0.47 | 0 | 1 | Dummy variable indicating if the source of irrigation information for the farmer was cooperative extension |
| Off-farm water cost per acre | 38.8 | 135.98 | 0 | 3147.07 | Cost of water per acre, for all off-farm sources (constant 2003 USD) |
| Average well depth | 63.30 | 100.24 | 0 | 726.67 | Average well depth of three major wells used for irrigation by the operation (feet) |
| Only gravity system | 0.31 | 0.46 | 0 | 1 | Dummy variable indicating if the farm used only gravity system for irrigation |
| Only sprinkler system | 0.07 | 0.26 | 0 | 1 | Dummy variable indicating if the farm used only sprinkler system for irrigation |
| Only drip, trickle and, sub-irrigation | 0.12 | 0.32 | 0 | 1 | Dummy variable indicating if the farm used only drip, trickle, or sub-irrigation system for irrigation |
| All irrigation systems | 0.07 | 0.25 | 0 | 1 | Dummy variable indicating if the farm used some combination of all three systems for irrigation |
| Frost mitigation | 0.13 | 0.34 | 0 | 1 | Dummy variable indicating whether the farm used irrigation water for frost mitigation |
| Heat mitigation | 0.06 | 0.23 | 0 | 1 | Dummy variable indicating whether the farm used irrigation water for crop cooling, or heat mitigation |
| Mean annual precipitation | 1.29 | 0 .69 | 0 .21 | 4.30 | Weighted mean annual county precipitation (inch) |

| Table 1. Variable description and summary statistics (continued) | | | | | |
|---|---|---|---|---|---|
| **Variable** | **Mean** | **Standard Deviation** | **Minimum** | **Maximum** | **Description** |
| Mean annual temperature | 61.90 | 4.44 | 44.98 | 75.30 | Weighted mean annual county temperature (degree F) |
| Leaching | 0.06 | 0.24 | 0 | 1 | Dummy variable indicating whether the farm used irrigation water for leaching the soil of salts |
| Fruit and nut crops | 0.38 | 0.49 | 0 | 1 | Dummy variable indicating whether the farm harvested fruit and nut crops |
| Corn | 0.17 | 0.37 | 0 | 1 | Dummy variable indicating whether the farm harvested corn |
| Vegetables | 0.21 | 0.40 | 0 | 1 | Dummy variable indicating whether the farm harvested vegetables |
| Wheat | 0.19 | 0.39 | 0 | 1 | Dummy variable indicating whether the farm harvested wheat |
| Alfalfa | 0.29 | 0.45 | 0 | 1 | Dummy variable indicating whether the farm harvested alfalfa |
| Pasture | 0.09 | 0.28 | 0 | 1 | Dummy variable indicating whether the farm harvested pasture |
| Hay | 0.14 | 0.35 | 0 | 1 | Dummy variable indicating whether the farm harvested hay |
| Farmer age | 57.10 | 12.70 | 17 | 96 | Farmer age (years) |
| UCCE*farmer age | 18.42 | 27.56 | 0 | 96 | Interaction between UCCE and farmer age |
| Principal occupa-tion farmer | 0.87 | 0.33 | 0 | 1 | Dummy variable indicating whether the operator's principal occupation is farming or ranching |
| Hired manager | 0.18 | 0.39 | 0 | 1 | Dummy variable indicating whether the principal operator is a hired manager |
| Farmer experience | 24.87 | 14.25 | 1 | 73 | Farmer experience, represented by number of years the farmer has been working on the farm |

**Table 2. Coefficient estimates for model with value of agricultural products per irrigated acre as dependent variable**

| Dependent variable<br>Value of agricultural output per irrigated acre | Coefficient estimates |
|---|---|
| UCCE | 3,035*<br>(1,628) |
| UCCE*farmer age | −53.22**<br>(24.91) |
| Farmer age | −6.79<br>(61.60) |
| Farmer age squared | 0.11<br>(0.49) |
| Off-farm water cost per acre | 1.63<br>(1.10) |
| Average well depth | 2.45<br>(4.80) |
| Average well depth squared | 0.0005<br>(0.007) |
| Only gravity system | −9.63<br>(392.8) |
| Only sprinkler system | −1,864***<br>(471.4) |
| Only drip, trickle, and sub-irrigation | −402.7<br>(399.5) |
| All irrigation systems | 3,091**<br>(1,180) |
| Frost mitigation | −964.5*<br>(505.8) |
| Heat mitigation | 1,563**<br>(689.1) |
| Leaching | −390.9<br>(876.6) |
| Mean annual precipitation | 2,078<br>(1,588) |
| Mean annual temperature | 358.4<br>(1,212) |
| Mean annual precipitation square | −353.6<br>(263.3) |
| Mean annual temperature square | −0.70<br>(8.90) |
| Vegetables | 15,906***<br>(1,855) |
| Corn | 1,362**<br>(516.8) |
| Wheat | 660.3<br>(697.5) |
| Alfalfa | −28.00<br>(1,016) |
| Pasture | −580.4<br>(441.9) |
| Hay | 569.0*<br>(287.0) |
| Principal occupation farmer | −0.51<br>(357.0) |
| Hired manager | −57.82<br>(422.0) |
| Farmer experience | -3.99<br>(10.08) |
| Constant | −20,570<br>(40,222) |
| **Observations** | **1,917** |
| **R-squared** | **0.613** |
| **County FE** | **YES** |
| **Year FE** | **YES** |

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

**Table 3. Coefficient estimates for model with water applied per irrigated acre as the dependent variable**

| Dependent variable<br>Water applied (acre-ft.) per acre of irrigated land | Coefficient estimates |
|---|---|
| UCCE | 1.17***<br>(0.33) |
| UCCE*farmer age | −0.014**<br>(0.006) |
| Farmer age | 0.007<br>(0.02) |
| Farmer age squared | −4.49e-05<br>(0.0002) |
| Off farm water cost per acre | 0.0009<br>(0.0006) |
| Average well depth | 0.006***<br>(0.0008) |
| Average well depth squared | −1.04e-05***<br>(2.10e-06) |
| Only gravity system | 1.33***<br>(0.13) |
| Only sprinkler system | 0.46***<br>(0.16) |
| Only drip, trickle, and sub-irrigation | 0.38**<br>(0.16) |
| All irrigation systems | 0.07<br>(0.16) |
| Frost mitigation | 0.24**<br>(0.11) |
| Heat mitigation | 0.15<br>(0.13) |
| Leaching | 0.16<br>(0.15) |
| Mean annual precipitation | −0.07<br>(1.14) |
| Mean annual temperature | −0.43<br>(0.47) |
| Mean annual precipitation square | −0.02<br>(0.22) |
| Mean annual temperature square | 0.004<br>(0.004) |
| Fruit and nuts | 0.75***<br>(0.09) |
| Vegetables | 0.65***<br>(0.10) |
| Corn | 0.09<br>(0.16) |
| Wheat | 0.05<br>(0.09) |
| Alfalfa | 0.63***<br>(0.14) |
| Pasture | 0.43***<br>(0.16) |
| Hay | 0.44***<br>(0.16) |
| Principal occupation farmer | −0.14<br>(0.11) |
| Hired manager | −0.11<br>(0.10) |
| Farmer experience | 0.001<br>(0.003) |
| Constant | 12.75<br>(14.83) |
| **Observations** | **1,917** |
| **R-squared** | **0.508** |
| **County FE** | **YES** |
| **Year FE** | **YES** |

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

**Table 4. Coefficient estimates for model with water applied per irrigated acre as the dependent variable, including farmer age groups as covariates**

| Dependent variable<br>Water applied acre-feet/acre of irrigated land | Coefficient estimates |
|---|---|
| UCCE | 0.61***<br>(0.17) |
| Age 40–50 | 0.04<br>(0.16) |
| Age 50–60 | −0.05<br>(0.23) |
| Age 60–70 | −0.08<br>(0.29) |
| Age 70–80 | 0.24<br>(0.30) |
| Above age 80 | 0.03<br>(0.36) |
| UCCE*(40–50) | −0.09<br>(0.21) |
| UCCE*(50–60) | −0.13<br>(0.21) |
| UCCE*(60–70) | −0.23<br>(0.22) |
| UCCE*(70–80) | −0.75**<br>(0.30) |
| UCCE*(above 80) | −0.78**<br>(0.38) |
| Farmer age | 0.01<br>(0.04) |
| Farmer age squared | −0.0001<br>(0.0003) |
| Off-farm water cost per acre | 0.0008<br>(0.0006) |
| Average well depth | 0.006***<br>(0.0008) |
| Average well depth squared | -1.04e-05***<br>(2.09e-06) |
| Only gravity system | 1.33***<br>(0.13) |
| Only sprinkler system | 0.43***<br>(0.15) |
| Only drip, trickle, and sub-irrigation | 0.37**<br>(0.17) |
| All irrigation systems | 0.07<br>(0.16) |
| Frost mitigation | 0.25**<br>(0.11) |
| Heat mitigation | 0.14<br>(0.13) |
| Leaching | 0.16<br>(0.15) |
| Mean annual precipitation | −0.06<br>(1.15) |
| Mean annual temperature | −0.45<br>(0.48) |
| Mean annual precipitation square | −0.02<br>(0.22) |
| Mean annual temperature square | 0.004<br>(0.004) |
| Fruit and nuts | 0.75***<br>(0.09) |
| Vegetables | 0.64***<br>(0.10) |
| Corn | 0.10<br>(0.16) |
| Wheat | 0.04<br>(0.09) |
| Alfalfa | 0.64***<br>(0.14) |
| Pasture | 0.43**<br>(0.16) |
| Hay | 0.45***<br>(0.15) |
| Principal occupation farmer | −0.15<br>(0.11) |
| Hired manager | −0.12<br>(0.10) |
| Farmer experience | 0.001<br>(0.003) |
| Constant | 13.32<br>(15.12) |
| **Observations** | **1,917** |
| **R-squared** | **0.511** |
| **County FE** | **YES** |
| **Year FE** | **YES** |

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

**Table 5. Coefficient estimates for model with value of agricultural products per irrigated acre as the dependent variable, and a combination of UCCE and at least one other source of irrigation information as an independent variable**

| Dependent variable<br>Value of agricultural output per irrigated acre | Coefficient estimates |
|---|---|
| Information combination | 2,813*<br>(1,650) |
| Farmer age* Information combination | −51.12*<br>(26.28) |
| Farmer age | −0.36<br>(62.02) |
| Farmer age squared | 0.036<br>(0.48) |
| Off-farm water cost per acre | 1.62<br>(1.10) |
| Average well depth | 2.53<br>(4.76) |
| Average well depth squared | 0.0004<br>(0.007) |
| Only gravity system | -8.04<br>(389.0) |
| Only sprinkler system | -1,854***<br>(471.8) |
| Only drip, trickle, and sub-irrigation | -390.2<br>(397.7) |
| All irrigation systems | 3,100**<br>(1,183) |

**Table 5. Coefficient estimates for model with value of agricultural products per irrigated acre as the dependent variable, and a combination of UCCE and at least one other source of irrigation information as an independent variable**

| Dependent variable<br>Value of agricultural output per irrigated acre | Coefficient estimates |
|---|---|
| Frost mitigation | −943.6*<br>(516.8) |
| Heat mitigation | 1,586**<br>(684.2) |
| Leaching | −378.9<br>(876.7) |
| Mean annual precipitation | 2,108<br>(1,588) |
| Mean annual temperature | 319.9<br>(1,203) |
| Mean annual precipitation square | −364.8<br>(264.0) |
| Mean annual temperature square | −0.34<br>(8.86) |
| Vegetables | 15,913***<br>(1,856) |
| Corn | 1,370**<br>(514.3) |
| Wheat | 649.2<br>(694.9) |
| Alfalfa | −16.96<br>(1,024) |
| Pasture | −600.6<br>(445.7) |
| Hay | 573.5*<br>(286.3) |
| Principal occupation farmer | −9.434<br>(361.3) |
| Hired manager | −55.45<br>(425.0) |
| Farmer experience | −4.087<br>(10.08) |
| Constant | −19,547<br>(39,810) |
| **Observations** | **1,917** |
| **R-squared** | **0.613** |
| **County FE** | **YES** |
| **Year FE** | **YES** |

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

**Table 6. Coefficient estimates for model with water applied per irrigated acre as the dependent variable, and a combination of UCCE and at least one other source of irrigation information as an independent variable**

| Dependent variable<br>Water applied (acre-ft.) per acre of irrigated land | Coefficient estimates |
|---|---|
| Information combination | 1.03***<br>(0.30) |
| Farmer age* Information combination | −0.01**<br>(0.006) |
| Farmer age | 0.009<br>(0.02) |
| Farmer age squared | −6.98e-05<br>(0.0002) |
| Off-farm water cost per acre | 0.0009<br>(0.0006) |
| Average well depth | 0.006***<br>(0.0008) |
| Average well depth squared | −1.04e-05***<br>(2.11e-06) |
| Only gravity system | 1.34***<br>(0.14) |
| Only sprinkler system | 0.46***<br>(0.16) |
| Only drip, trickle, and sub-irrigation | 0.38**<br>(0.17) |
| All irrigation systems | 0.07<br>(0.16) |
| Frost mitigation | 0.25**<br>(0.11) |
| Heat mitigation | 0.16<br>(0.12) |
| Leaching | 0.16<br>(0.15) |
| Mean annual precipitation | −0.09<br>(1.13) |
| Mean annual temperature | −0.46<br>(0.48) |
| Mean annual precipitation square | −0.01<br>(0.22) |
| Mean annual temperature square | 0.004<br>(0.004) |
| Fruit and nuts | 0.76***<br>(0.10) |
| Vegetables | 0.65***<br>(0.10) |
| Corn | 0.09<br>(0.16) |
| Wheat | 0.05<br>(0.09) |
| Alfalfa | 0.64***<br>(0.14) |
| Pasture | 0.44***<br>(0.16) |
| Hay | 0.44***<br>(0.16) |

| Table 6. Coefficient estimates for model with water applied per irrigated acre as the dependent variable, and a combination of UCCE and at least one other source of irrigation information as an independent variable | |
|---|---|
| **Dependent variable**<br>**Water applied (acre-ft.) per acre of irrigated land** | **Coefficient estimates** |
| Principal occupation farmer | −0.14<br>(0.11) |
| Hired manager | −0.11<br>(0.10) |
| Farmer experience | 0.001<br>(0.003) |
| Constant | 13.77<br>(14.92) |
| **Observations** | **1,917** |
| **R-squared** | **0.506** |
| **County FE** | **YES** |
| **Year FE** | **YES** |

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

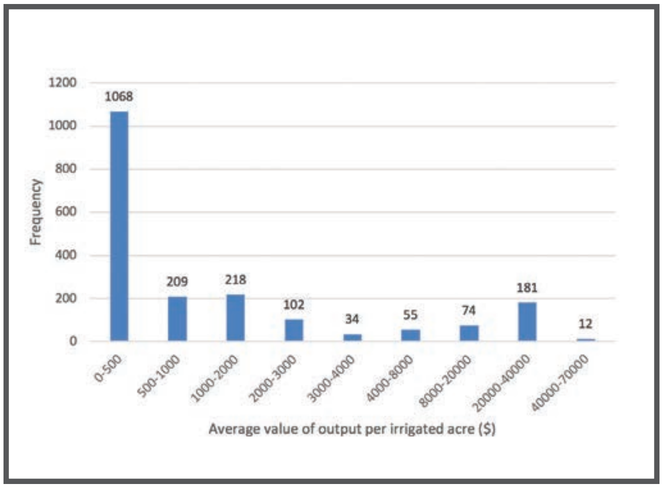



Figure 1. Distribution of average value of agricultural output per irrigated acre (2003 prices)

Source: Elaborated by authors, based on FRIS.
Note: Values on top of bars represent number of farms in that category.

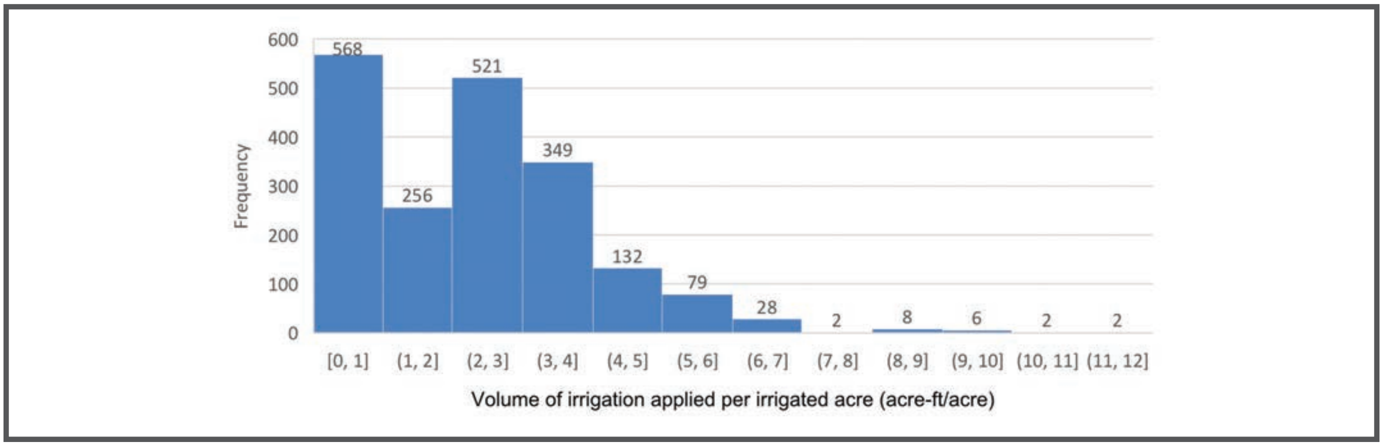



Figure 2. Distribution of the values of volume of irrigation water applied per irrigated acre

Source: Elaborated by authors, based on FRIS.
Note: Values on horizontal axis represent range of water per acre; values on top of bars represent number of farms in that category.

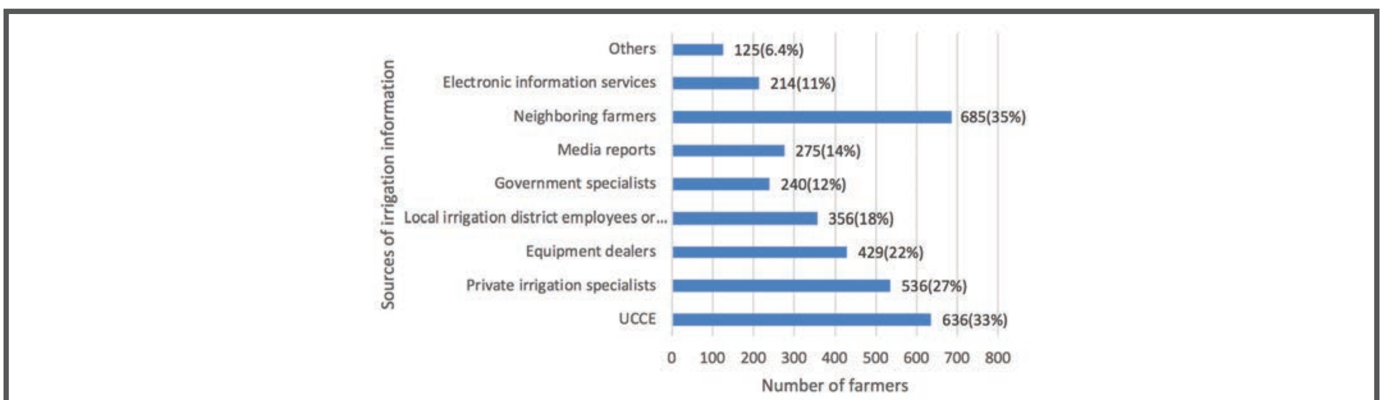



Figure 3. Farmer irrigation information sources by type and number (%) of users, 2003

Source: Elaborated by authors based on FRIS.
Note: Values on top of the bars represent the number (and percentage) of farms in that category.

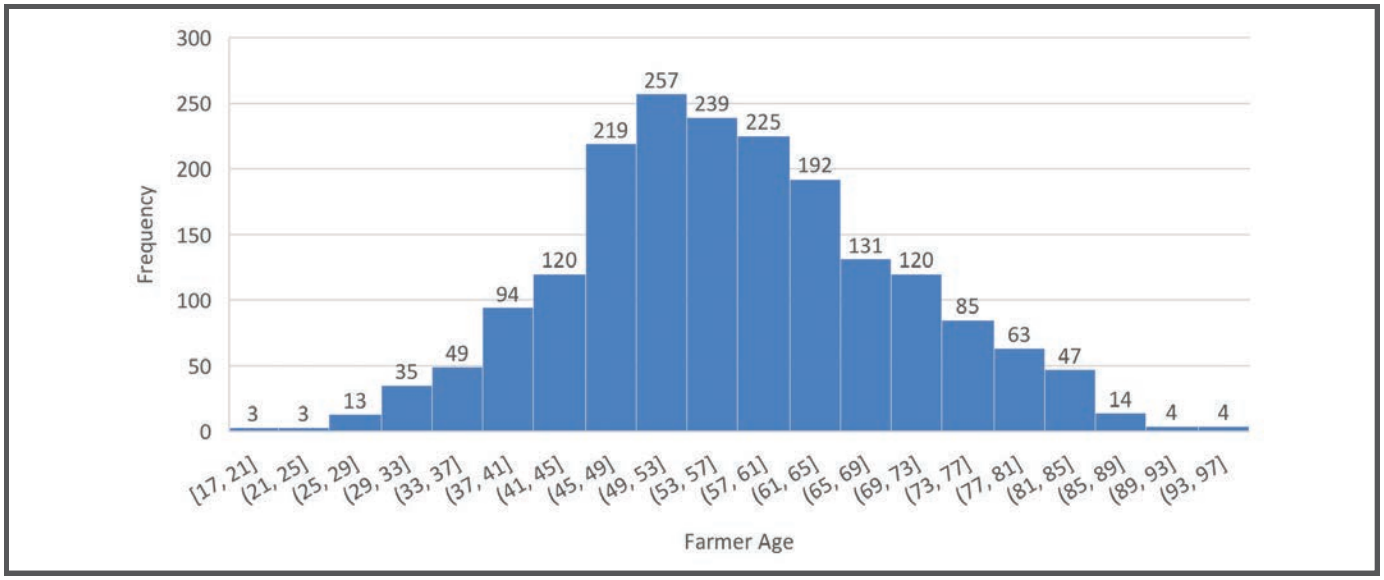



Figure 4. Frequency distribution of farmers by age

Source: Elaborated by authors, based on FRIS.
Note: Values on horizontal axis represent range of farmer's age. Values on top of bars represent number of farmers in that category.

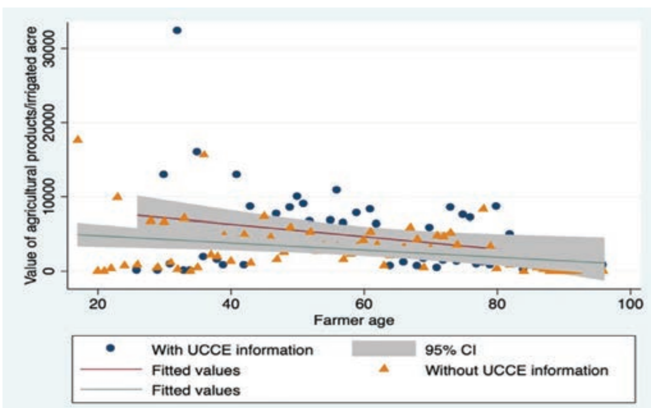



Figure 5. Mean value of agricultural output per irrigated acre for each farmer age, for users and non-users of UCCE irrigation knowledge

Note: Purple line represents fitted values of "with UCCE information," and light blue line represents fitted values of "without UCCE information."

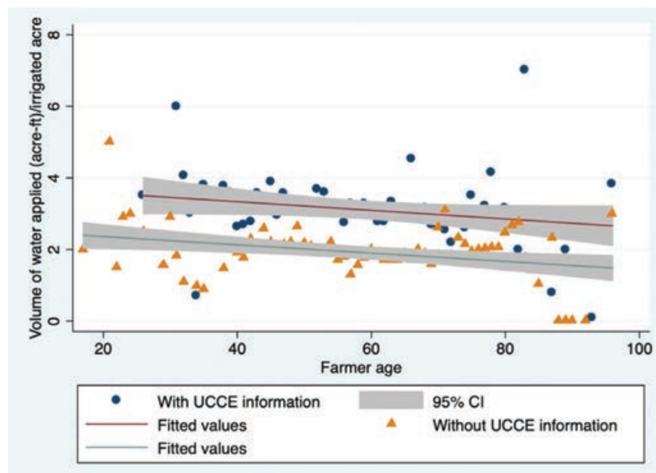



Figure 6. Mean value of irrigation water usage per irrigated acre for each farmer age, for users and non-users of UCCE irrigation knowledge

Note: Purple line represents fitted values of "with UCCE information," and light blue line represents fitted values of "without UCCE information."

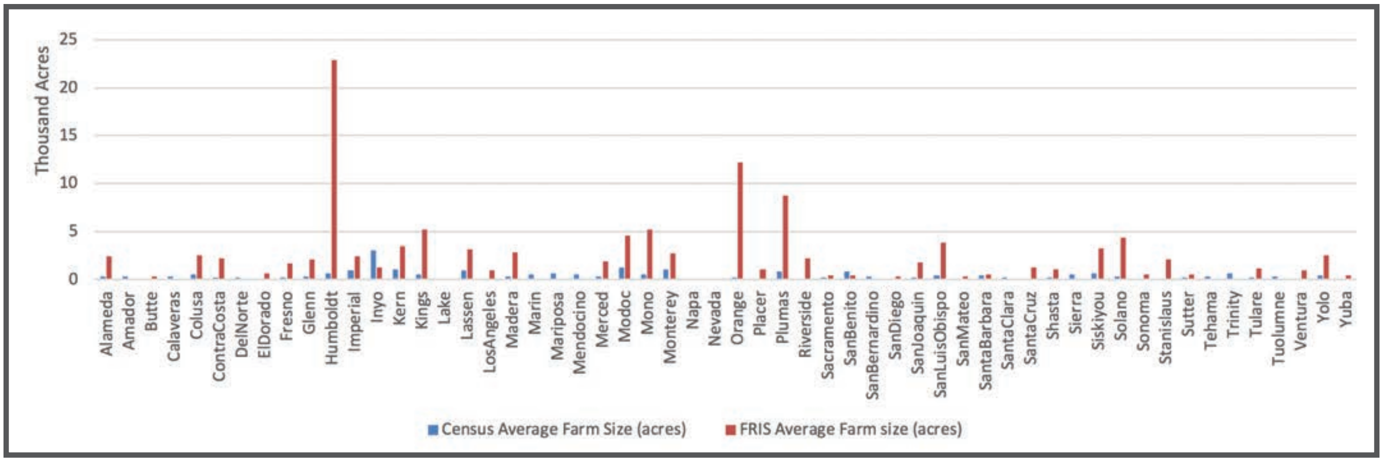
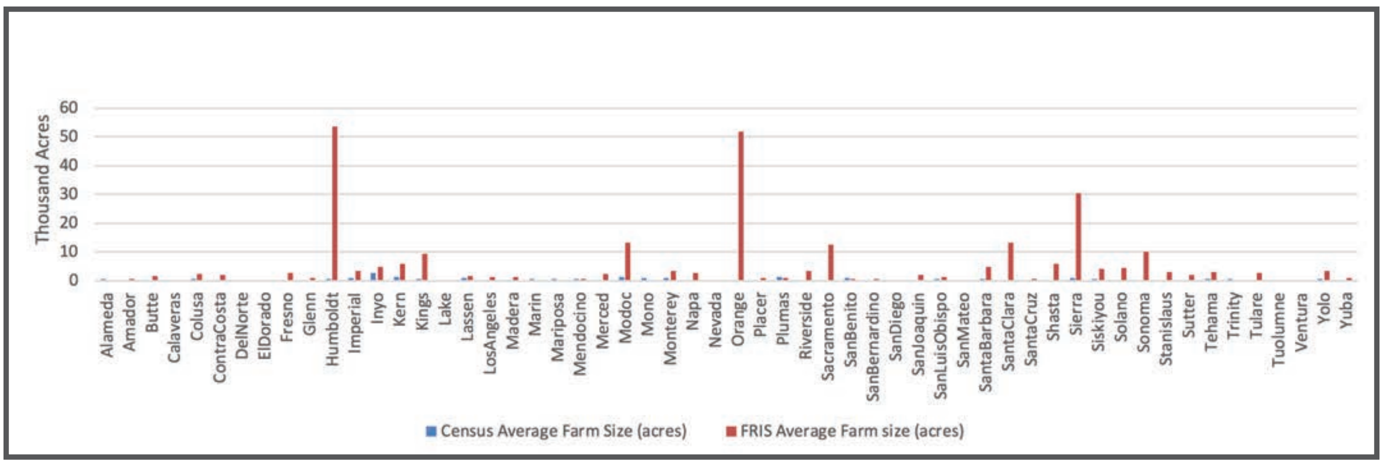



Figure A1. Panel (a). Average County Farm Size in 2003 — A comparison between Agricultural Census and FRIS




Panel (b). Average County Farm Size in 2008 — A comparison between Agricultural Census and FRIS

# The Impact of Bank Concentration on Land Values

**By Ana Claudia Sant'Anna, Ani L. Katchova**

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### Abstract

*Scheduled increases in interest rates coupled with local bank concentration affects credit availability. Credit availability helps determine land values. A regression analysis is used to estimate the impact of bank concentration on land values. Although real estate loans do not need to come from local banks, higher market concentration in the banking sector was found to be related to lower land values. Counties with a 1 percent higher concentration in banks measured by the HHI index have land values that are lower by $276.17 per acre on average. Bank diversification, fewer lender-borrower relationships or greater monopolistic behavior of local banks may reduce credit availability and consequently result in lower land values.*

## INTRODUCTION

As the Federal Reserve Bank has made announcements to increase interest rates throughout 2018 and coming years, there is concern over the behavior of land values, a major component of farm assets (i.e., over 80 percent). The land value stability and its changes provide indications of the financial health and strength of the agricultural sector. Higher interest rates coupled with declining farm values may limit farmers' access to credit and, consequently, their acquisition of land. Additionally, higher interest rates may make investments other than land more attractive, pressuring land values downward. As such, interest rates have an inverse relationship to land values. Nevertheless, despite announced increases in federal fund rates, market interest rates have increased at a slower pace (Zulauf, 2018). In fact, market interest rates have been higher than federal funds rates. Market competition in the banking sector plays a role in the interest rates and credit availability. Banks with greater market share, in seeking to minimize their risks, may limit credit availability or even use their market power to increase interest rates on their loans (Hellmann, Murdock, & Stiglitz, 2000; Beck, Demirguc-Kunt, & Levine, 2003). Higher credit availability has been linked to rapid increases in land values (Shalit & Schmitz, 1982). Hence, we seek to assess the relationship between local bank concentration and land values at a time when lending is not necessarily at the local bank market. Our objective is to measure the relationship between the concentration in the banking sector and land values in a county.

Land is usually acquired by taking out a loan, making the demand for land dependent on credit availability (Rajan & Ramcharan, 2015). Access to land is a barrier faced by those seeking to enter into farming and those seeking to expand their farming operations. As interest rates increase, so do borrowing costs, making land acquisition harder. Additionally, decreases in land values could mean less access to loans secured by farmland. When taking out a loan, interest rates and collateral are both negotiated (Geanakoplos, 2010). The composition of the banking market can influence the number of agricultural loans offered (Levonian, 1996). Despite modern day technology, rural banks continue to be an important source of credit to local farmers (Nam, Ellinger, & Katchova, 2007). In this study, we concentrate on commercial banks, as they account for around 42 percent of the debt on U.S. farms (over one-third of real estate loans and close to a half of non-real estate loans) (ERS/USDA, 2018). In 2012, debt in real estate loans held by commercial banks increased by 18 percent, which is higher than the total real estate debt in the farm sector (3.6 percent) or the real estate held by the farm credit system (6 percent) (ERS/USDA, 2018).

Events such as the concentration trend of farms becoming larger over time and bank mergers can promote the closure of branches or their portfolio diversification (Bunge, 2017; Beck, Demirguc-Kunt, & Levine, 2003). Banks may opt to diversify their portfolio by reducing the amount of agricultural lending (Nam, Ellinger, & Katchova, 2007). Also, as profits increase, banks may become less prone to take on exorbitant risks (Hellmann, Murdock, & Stiglitz, 2000). This, in turn, may limit credit availability, as more concentrated banks may increase their loan requirements. In addition, banks with more market power can have a monopolistic behavior, charging higher interest rates to their customers (Beck, Demirguc-Kunt, & Levine, 2003). It appears, therefore, that market interest rates and credit availability are affected by the market composition and market share of banks at the local level.

## LITERATURE REVIEW

The number of banking companies and branches has declined over the years. Over 10,000 mergers have taken place since the 1980s, and the number of banks operating has decreased from 19,069 in the 1980s to 7,011 in 2010 (Adams, 2012). In 2010, the 10 largest banks held more than 50 percent of the assets. How bank mergers and, consequently, greater concentration of banks at the local level affect agricultural loans is controversial. As banks become larger their loans to small businesses, such as farms, may decrease (Berger & Udell, 1995). Furthermore, when the acquiring bank has a small agricultural loan concentration, agricultural lending tends to be reduced (Ahrendsen, Dixon, & Lee, 1999). However, bank consolidation at the local level does not always imply a decline in agricultural loans (Featherstone, 1996). Local agricultural loans may increase as an extra source of liquidity becomes available (Keeton, 1996). Regardless, the increase or decrease in credit affects the behavior of land values (Shalit & Schmitz, 1982).

Linkages between credit availability, interest rates, and land values have been the topic of past studies. Rajan and Ramcharan (2015) find that credit availability caused inflated land prices during the Great Depression. Devadoss and Manchu (2007) find that an increase of 1 percent in credit availability increases farmland values in Idaho by 1.40 percent. The quantity of loans, or credit available, is influenced by the market composition of the banking sector (Levonian, 1996).

We provide a fresher look at this topic by analyzing how land values in a county can be linked to the concentration in the banking sector within the same county. We use a common indicator of market concentration: the Herfindahl-Hirschman Index (HHI) to measure the concentration among banks in a county. The HHI is used by federal banking agencies to access bank mergers and acquisitions (Morris, Wilkinson, & Hogue, 2015). The HHI is the sum of the squares of market shares held by each company (Rhoades, 1993). It is expected that a greater concentration in the bank market promotes higher loan interest rates and stricter loan requirements, making credit access more restricted.

Access to credit is vital to land acquisition and, as such, plays a role in land purchases and its prices (Devadoss & Manchu, 2007). Farmland prices are partly determined by the amount of debt they can carry (Shalit & Schmitz, 1982). Land values rise faster when credit supply increases than when credit is unavailable (Shalit & Schmitz, 1982). The relationship between agricultural loans and land values can be described in a cycle (Shalit & Schmitz, 1984). Land values tend to increase together with greater credit availability (Shalit & Schmitz, 1984). Over time, debt accumulation causes land values to fall as land is sold to uphold farmers' financial responsibilities and guarantee the sustainability of the farming operation (Shalit & Schmitz, 1982). As land values fall, loan requirements become stricter. Therefore, credit availability can have positive and negative impacts on land values. Greater credit availability can also make the economy more sensitive to fundamental shocks, with bank failures and losses being greater in areas with more credit availability prior to a crisis (Rajan & Ramcharan, 2015; Shalit & Schmitz, 1982). As such, the increase and decrease in credit availability affects the growth or reduction rate of land values.

## DATA AND MODEL

Data on agricultural production, government payments, taxes, farmland acres, and land values for the 48 contiguous states in the U.S. are from the 2012 Census of Agriculture. Information on population, county areas, 2013 rural and urban Continuum Code, and 2015 economic typology code is from the U.S. Census. The natural amenities scale (Zscale) is provided by the Economic Research Service in the United States Department of Agriculture website. Information on banks and deposits per county is from the Federal Deposit Insurance Corporation. These are used to construct the Herfindahl-Hirschman Index (HHI) which provides an indication of banking concentration. The higher the values of the HHI, the more concentrated the banking sector is, and there is less competition among banks in a county. The HHI is calculated as the sum of the market shares of the deposits for each bank in the county (Rhoades, 1993):

$$(1) \quad HHI_{county} = \sum_{B=1}^{N} \left( \frac{deposits_B}{total\ deposits\ in\ the\ county} \right)^2$$

The market share of each bank is measured as the ratio of the amount of deposits for each bank over the total deposits for all banks in the county (Rhoades, 1993). This provides a proxy for the liquidity and capacity of the bank (Rajan & Ramcharan, 2015) and is a good measure of banking activity at the local branch level (Morris, Wilkinson, & Hogue, 2015).

The model then estimates land value per acre as a linear function of the value of production from agriculture per acre, *government payments* per acre received from public policies, bank concentration given by the *HHI* index, amount paid in *property taxes* per acre, the region in which the county is located, and *other county variables*:

$$(2) \quad land\ value = f(value\ of\ production, government\ payments, property\ taxes, HHI, region, other\ county\ variables)$$

where *other county variables* is a set of variables composed of a scale of natural amenities, population density, the county economic type, and the urban-rural county index. *Region* encompasses the regions: Northeast, Lake States, Corn Belt, Northern Plains, Appalachian, Southeast, Delta States, Southern Plains, Mountain, and Pacific. The government payments do not include payments made through the conservation reserve program (CRP), as these usually are paid to land with lower quality and not in agricultural production (Kropp & Peckham, 2015). All variables, with the exception of the rural and economic continuum codes and the natural amenities scale, were transformed by taking the natural logarithm. It is important to control for population density and rural areas because these could influence not only farmland values but also the market concentration of banks in a county. More rural areas, with fewer economic activities than metropolitan areas, may not be able to support a large number of banks (Morris, Wilkinson, & Hogue, 2015). Furthermore, we use the share of acres owned by the operator to total farmland operated in the county as a weight. As such, each observation is divided by the standard deviation of the share of operated land that is owned. Variables were chosen based on previous studies that investigate the determinants of land values (Kropp & Peckham, 2015; Devadoss & Manchu, 2007; Rajan & Ramcharan, 2015). Common to all studies are the variables that relate to land values, returns from the land, urban pressures, and opportunity costs from investing in land. Nevertheless, other factors have been found to influence land values: policy (e.g., government payments and taxes) and other macroeconomic factors (e.g., credit availability).

Table 1 presents descriptive statistics of the variables used in the model. Land values in the U.S. ranged from $202/acre to $19,686/acre in 2012. Values over $20,000/acre and under $200/acre were excluded in order to remove observations associated with non-typical agricultural activities or resulting from confusion in part of the respondent (Kropp & Peckham, 2015). On average the *value of agricultural production* was $588.70/acre, the average received in government payments was under $10 per acre, and the taxes paid were $13.71 per acre in 2012. Bank concentration at the county level ranges from 671 to 10,000. The value of 10,000 is the highest HHI, occurring when one bank in the county holds all the market share. There is greater bank concentration at the county level than at the national level. In 2012, there were over 6,200 commercial banks in the United States, while at the county level the average number of commercial banks was of two to three banks. Hence, at the national level the banking market is more competitive with an HHI of 0.22. An HHI of zero is a totally competitive market.

## RESULTS

Results from the econometric regression are presented in Table 2. The model explains over 80 percent of the variation in the data. Figure 1 shows how on average land values predicted by the model resemble the observed land values. For most regions the land values predicted by the model reflect on average the observed land values. The estimation passed statistical tests such as those to check for missing variables, model specification, and correlation between the variables. Tests indicate that the model is correctly specified.

Counties with higher values of agricultural production have higher land values. This reflects how land with greater productive capacity has higher values. Counties with a 1 percent higher value of agricultural production have land values that were 6.3 percent higher per acre. An increase of $6 per acre on the average agricultural production value is associated with average increases of $223 in land values per acre. In counties where farmers have higher tax expenses, land values are higher. Higher taxes, though, could discourage a farmer from buying land (Devados & Manchu, 2007). Higher taxes could also be an indication of a land with higher production capacity, as taxes are usually charged as a percentage of land value or agricultural production. Factors external to farming also play a role in land values. The county's location, its population, main economic activity, and urban settings help determine its land values. Counties with larger populations or in more urban settings have higher land values. An extra 1.5 person per square mile is associated with an increase in land values, on average, of $0.34 per acre. A change from 5 to 6 in the urban-rural county index, that is, a change to a more rural setting, decreases land values on average by $91 per acre. The coefficients on the categorical variables, those related to economic dependency type and region, are interpreted relative to land values in nonspecialized counties in the Northeast region. Nonspecialized counties are those that are outside of the economic dependence categories set by the USDA-ERS. Land values in recreational counties are on average $321 per acre higher than those in nonspecialized counties. Similarly, land values differ between regions. Nonspecialized counties in the Northeast region have on average lower land values than counties in other regions with an economic specialization.

Bank consolidation can have positive or negative effects on credit availability and, consequently, on land values. Although real estate loans do not necessarily need to be from local banks, we find that lower market competition in the banking sector is related to lower land values in a county. Counties with a 1 percent higher concentration in banks measured by HHI have 7.8 percent lower land values, a decrease, on average, of $276.17 per acre. Bank concentration seems to be linked to lower land values by limiting credit availability. A number of factors could explain how bank concentration can limit credit availability: 1) Lower market competition may allow banks to behave more like monopolists, increasing interest rates and loan requirements, reducing credit availability, and potentially decreasing demand for land; 2) Larger banks may opt to diversify their portfolio, potentially reducing their investments in agricultural loans; 3) Farmers' dependency on local banks for loans (Keeton, 1996) means that a greater bank concentration reduces the borrowing options available.

## CONCLUSIONS

As interest rates are set to increase there are concerns that land values may decline. Access to farmland is an important barrier to overcome for those wishing to enter farming or expand their farm operations. Credit availability plays a vital role in land acquisition. The market composition of banks in a county influences interest rates and credit availability. Greater access to credit can increase demand for farmland, putting upward pressure on farmland prices. Bank mergers have been found to affect the variation in land values, through changes in agricultural loan volumes. This study looked at the correlation of bank concentration and land values. Results showed that counties with a greater bank concentration have lower land values than those with a more competitive bank market. Although lending may not be locally restricted, we find that local market competition in the banking sector can affect land values. Bank diversification, fewer lender-borrower relationships or greater monopolistic behavior of local banks may reduce credit availability and, consequently, land values.

## REFERENCES


Adams, Robert M. 2012. "Consolidation and Merger Activity in the United States Banking Industry from 2000 Through 2010." SSRN Scholarly Paper ID 2193886. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=2193886.

Ahrendsen, Bruce L., Bruce L. Dixon, and LaDerrek T. Lee. 1999. "Independent Commercial Bank Mergers and Agricultural Lending Concentration." *Journal of Agricultural and Applied Economics* 31 (2): 215–27.

Beck, Thorsten, Asli Demirguc-Kunt, and Ross Levine. 2003. "Bank Concentration and Crises." National Bureau of Economic Research. http://www.nber.org/papers/w9921.

Berger, Allen N., and Gregory F. Udell. 1995. "Universal Banking and the Future of Small Business Lending." FIN-95-009. NYU Working Paper. https://ssrn.com/abstract=1298316.

Bunge, Jacob. 2017. "Supersized Family Farms Are Gobbling Up American Agriculture." *Wall Street Journal*, October 23, 2017, sec. Markets. https://www.wsj.com/articles/the-family-farm-bulks-up-1508781895.

Devadoss, Stephen, and Viswanadham Manchu. 2007. "A Comprehensive Analysis of Farmland Value Determination: A County-Level Analysis." *Applied Economics* 39 (18): 2323–30. https://doi.org/10.1080/00036840600675687.

ERS/USDA, Farm Income and Wealth Statistics. 2018. "Farm Sector Balance Sheet, 2010–2018F." 2018. https://data.ers.usda.gov/reports.aspx?ID=17835.

Featherstone, Allen M. 1996. "Post-Acquisition Performance of Rural Banks." *American Journal of Agricultural Economics* 78 (3): 728–33. https://doi.org/10.2307/1243294.

Geanakoplos, John. 2010. "The Leverage Cycle." *NBER Macroeconomics Annual 2009, Volume 24*, April, 1–65.

Hellmann, Thomas F., Kevin C. Murdock, and Joseph E. Stiglitz. 2000. "Liberalization, Moral Hazard in Banking, and Prudential Regulation: Are Capital Requirements Enough?" *American Economic Review* 90 (1): 147–65.

Just, Richard E., and John A. Miranowski. 1993. "Understanding Farmland Price Changes." *American Journal of Agricultural Economics* 75 (1): 156–68. https://doi.org/10.2307/1242964.

Keeton, William R. 1996. "Do Bank Mergers Reduce Lending to Businesses and Farmers? New Evidence from Tenth District States." *Economic Review-Federal Reserve Bank of Kansas City* 81: 63–76.

Kropp, Jaclyn, and Janet G. Peckham. 2015. "U.S. Agricultural Support Programs and Ethanol Policies Effects on Farmland Values and Rental Rates." *Agricultural Finance Review* 75 (2): 169–93. https://doi.org/10.1108/AFR-06-2014-0015.

Levonian, Mark E. 1996. "Explaining Differences in Farm Lending among Banks." *Economic Review-Federal Reserve Bank of San Francisco*, no. 3: 12.

Morris, Charles S., James Wilkinson, and Eric Hogue. 2015. "Competition in Local Agricultural Lending Markets: The Effect of the Farm Credit System." *Economic Review-Federal Reserve Bank of Kansas City*, 51.

Nam, Sangjeong, Paul N. Ellinger, and Ani L. Katchova. 2007. "The Changing Structure of Commercial Banks Lending to Agriculture." In *Urbana*, 51:34. Portland, Oregon.

Rajan, Raghuram, and Rodney Ramcharan. 2015. "The Anatomy of a Credit Crisis: The Boom and Bust in Farm Land Prices in the United States in the 1920s." *American Economic Review* 105 (4): 1439–77. https://doi.org/10.1257/aer.20120525.

Rhoades, Stephen A. 1993. "The Herfindahl-Hirschman Index." Fed. Res. Bull. 79: 188.

Shalit, Haim, and Andrew Schmitz. 1982. "Farmland Accumulation and Prices." *American Journal of Agricultural Economics* 64 (4): 710–19. https://doi.org/10.2307/1240580.

———. 1984. "Farmland Price Behavior and Credit Allocation." *Western Journal of Agricultural Economics*, 303–13.

Zulauf, C. 2018. "Interest Rates in 30-Year Perspective: The Case of U.S. 10-Year Treasury Rates." *Farmdoc Daily* (8):115, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, no. 8 (June): 115.

Table 1: Summary statistics of the variables in the model

| Variable | Decription | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Land Value | Land value ($/acre) | 3,540.73 | 2,446.53 | 202.00 | 19,686.00 |
| Production Value | Value of agricultural production ($/acre) | 588.70 | 785.10 | 2.78 | 22,762.61 |
| HHI | Herfindahl-Hirschman Index - higher values are associated with greater market concentration. Ranges from 0 to 10,000 | 6,653 | 2,835 | 671 | 10,000 |
| Taxes | Taxes paid ($/acre) | 13.71 | 15.53 | 0.16 | 184.87 |
| Government Payments | Amount received from the government ($/acre) | 9.67 | 7.05 | 0.08 | 41.37 |
| Population Density | Population over county acreage | 148.86 | 511.71 | 0.22 | 21,048.68 |
| Urban-Rural County Index | U.S. Census defined category from 1-9 with higher numbers representing more rural locations | 5.05 | 2.68 | 1.00 | 9.00 |
| County Economic Type | U.S. Census Economic-dependence county indicator | | | | |
| Nonspecialized | Counties outside of the economic dependence threshold | 0.39 | 0.49 | 0.00 | 1.00 |
| Farm-dependent | Counties with 25% or more of earnings in farming or 16% or more of jobs in farming | 0.15 | 0.35 | 0.00 | 1.00 |
| Mining-dependent | Counties with 13% or more of earnings in mining or 8% or more of jobs in mining | 0.07 | 0.26 | 0.00 | 1.00 |
| Manufacturing-dependent | Counties with 23% or more of earnings from manufacturing or 16% or more of jobs in manufacturing | 0.16 | 0.37 | 0.00 | 1.00 |
| Government -dependent | Counties with 14% or more of earnings coming from the government | 0.13 | 0.33 | 0.00 | 1.00 |
| Recreation | Counties with a higher concentration of jobs, earnings and housing dedicated to recreation | 0.10 | 0.31 | 0.00 | 1.00 |
| Zscale | Measure of physical characteristics of a county ranging from | 0.03 | 2.27 | -6.40 | 11.17 |
| Region | | | | | |
| Northeast | Includes the states Connecticut, Delaware, Maine, Maryland, Massachussetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont | 0.07 | 0.26 | 0.00 | 1.00 |
| Lake States | Includes the states Michigan, Minnesota and Wisconsin | 0.08 | 0.27 | 0.00 | 1.00 |
| Corn belt | Includes the states of Illinois, Indiana, Iowa, Missouri and Ohio | 0.16 | 0.37 | 0.00 | 1.00 |
| Northern Plains | Includes the states in Kansas, Nebraska, North Dakota and South Dakota | 0.10 | 0.31 | 0.00 | 1.00 |
| Appalachian | Includes the states of Kentucky, North Carolina, Tennessee, Virginia and West Virginia | 0.15 | 0.36 | 0.00 | 1.00 |
| Southeast | Includes the states of Alabama, Florida, Georgia and South Carolina | 0.11 | 0.31 | 0.00 | 1.00 |
| Delta States | Includes the states of Arkansas, Louisiana and Mississippi | 0.07 | 0.26 | 0.00 | 1.00 |
| Southern Plains | Includes the states of Oklahoma and Texas | 0.11 | 0.31 | 0.00 | 1.00 |
| Mountain | Includes the states of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming | 0.09 | 0.29 | 0.00 | 1.00 |
| Pacific | Includes the states of California, Oregon and Washington | 0.04 | 0.20 | 0.00 | 1.00 |
| Weights - Share of land tenure | Share of acres operated that is owned by the operator of the total farmland in the county (%) | 41 | 18.17 | 4.25 | 100 |

Note: per acre information was obtained by dividing the total amount by the farmland acreage, similarly, population density was calculated by dividing total population in a county by its area in square miles.

Table 2: Parameter estimates from the weighted least squares model for 2012 with the logarithm of land values per acre as the dependent variable

| Variables | Coefficient | Standard Error |
|---|---|---|
| Production Value | 0.0634*** | 0.00925 |
| HHI for bank market concentration | -0.0787*** | 0.01390 |
| Taxes | 0.526*** | 0.01340 |
| Government Payments | 0.0125 | 0.00911 |
| Population Density | 0.000097*** | 0.00002 |
| Urban-Rural County Index | -0.0257 | 0.00317 |
| Farm-dependent | 0.0376 | 0.02360 |
| Mining-dependent | 0.0445 | 0.03010 |
| Manufacturing-dependent | -0.00938 | 0.01820 |
| Government -dependent | -0.00765 | 0.02050 |
| Recreation | 0.0909*** | 0.02770 |
| Natural Amenities Scale | -0.00318 | 0.00529 |
| Lake States | 0.101*** | 0.03380 |
| Corn belt | 0.464*** | 0.02930 |
| Northern Plains | 0.108*** | 0.03660 |
| Appalachian | 0.427*** | 0.03040 |
| Southeast | 0.300*** | 0.03050 |
| Delta States | 0.355*** | 0.03470 |
| Southern Plains | 0.249*** | 0.03520 |
| Mountain | 0.145*** | 0.04560 |
| Pacific | 0.263*** | 0.04950 |
| Constant | 6.894*** | 0.13900 |
| Counties | 1,946 | |
| R-squared | 0.811 | |

Levels of statistical significance of 1%, 5% and 10% are identified by *, ** and ***, respectively. Non-specialized counties and the northeast regions are the base cases. The share of land operated that is owned by the operator was used as weights.

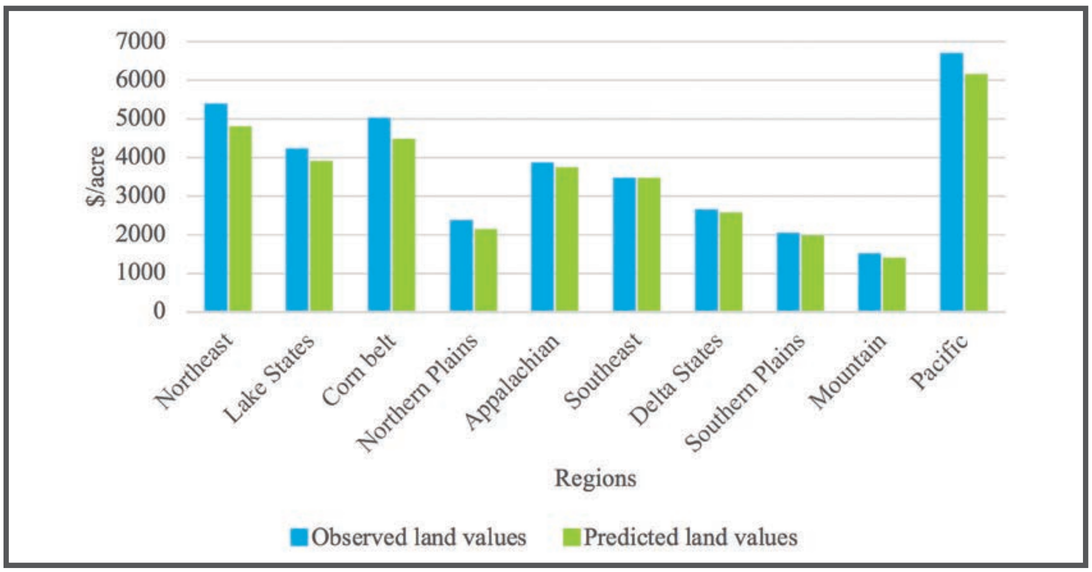


Figure 1: Land values predicted by the model versus observed land values by region in 2012

# Kansas Wheat Basis Expectations During Periods of Nonconvergence

**By Luke A. Minnix and Elizabeth A. Yeager**

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## Abstract

*Nonconvergence in commodity markets has caused some market participants to question the effectiveness of using futures contracts to effectively set target prices. This study examines 90 grain handling facilities across Kansas since 2004 and shows spatial patterns of change in hard red winter wheat basis with respect to basis movements at a regular (delivery) facility in Kansas City and the effect of nonconvergence. Producers and farm managers can more accurately predict changes in local basis with this information. Results indicate the presence of nonconvergence at delivery location has a significant effect on basis at some, but not all, outlying locations.*

## INTRODUCTION

Recent bouts of nonconvergence in agricultural commodities have raised concerns about the effectiveness of futures contracts. Nonconvergence occurs when cash prices diverge from the underlying futures contract more than anticipated during the delivery period. Traders expect the futures price and the cash price at a contract-specified delivery location to trend toward and meet each other as the futures contract matures, because of the threat of arbitrage and delivering against the contract. Nonconvergence results in wider than expected basis and increased risk exposure to market participants.

Futures markets are a central fixture in agricultural commodity marketing. Adjemian et al. (2013) discuss price discovery, risk management opportunities, and a source for storage signals as core functions of futures markets. Arguably, the most important task for the futures market is price discovery of the underlying commodity. As market participants buy and sell futures contracts, a consensus price of the good for a specific date in the future is determined. For the typical sale of physical grain, the cash price farmers receive will be equal to the current price of the nearby contract plus basis, which is the difference between the local cash and futures price. The basis should represent local supply and demand and the cost of transportation to an end user or delivery location. When nonconvergence is present, the price of futures contracts during the delivery period differs significantly from the cash price of the commodity. Adjemian, et al. (2013) argue that nonconvergence causes the price discovery function of the futures market to fail, as the futures price does not accurately represent the actual price of the physical commodity.

Producers and consumers of commodities use futures contracts and options to manage price risk by offsetting their cash position with an opposite futures position, known as hedging. Using futures to manage price risk, market participants are still subject to basis risk; however, basis has historically been more predictable than prices, and thus, basis risk is less risky than price risk. When futures markets are working properly, the expected net price resulting from hedging a commodity is equal to the futures price when the hedge was initiated plus expected basis. This effectively locks in a price for the commodity, and when basis is predictable, producers can eliminate price risk while taking advantage of expected improvements in basis. Adjemian et al. (2013)

explain that when nonconvergence is present, the value of the hedge is diminished because basis is no longer predictable, resulting in a higher risk premium because of a reduction in the probability of attaining the expected net price.

Predictability of basis helps to explain how futures markets produce storage signals. Basis varies by location and accounts for local supply and demand shifters as well as transportation costs to the nearest load-out facility. Irwin et al. (2008) explain that in a well-functioning futures market, basis is perfectly predictable at delivery points. When basis is predictable, Irwin et al. (2008) explain that holders of physical grain will store the grain if the cash price is under the futures with the expectation that cash price will rise to the futures price at the contract's expiration, resulting in an even basis. Figure 1, from Irwin et al. (2008), illustrates this concept of perfect predictability of basis at delivery locations. Another storage signal produced by the futures market comes from the nearby spread. If the difference in price between the nearby and deferred contract is greater than the cost to store the grain, owners of the physical commodity will store the grain with the expectation of realizing a better net price for the commodity in the future.

This paper will focus on local cash prices for wheat deliverable against the Chicago Board of Trade's (CBOT) Kansas City hard red winter (HRW) wheat contract across the state of Kansas since 2004. The objective of this paper is to determine spatial patterns in the rate of change of basis and the effect of nonconvergence on basis for cash bids of HRW wheat in Kansas. The results of the study are presented and discussed in a manner to allow producers and farm managers working with them to better understand wheat basis movements in their area (spatially across Kansas), in order to reduce basis uncertainty and maximize profits during a financially difficult period. This is accomplished using simple formulas and easily attainable data to provide a tool to every producer.

## NONCONVERGENCE

The specific cause of nonconvergence is debatable; however, the prevailing theory is associated with inefficiencies created by the fixed storage rates on delivery instruments. Delivery against an HRW wheat contract is done with a delivery instrument in lieu of the physical grain. Prior to the MAR '18 contract, warehouse receipts were the instrument used in the delivery process. Warehouse receipts give ownership of the contract-specified quantity (5,000 bu/contract) and quality of grain to the holder of the receipt and require the grain to be stored in the regular facility that issued the receipt. Moreover, regular facilities could only issue warehouse receipts for grain they had in inventory, limiting the number of outstanding warehouse receipts to the storage capacity of regular facilities. With the MAR '18 contract, the CBOT made significant changes to the HRW wheat contract including the switch from warehouse receipts to shipping certificates. The amendments to the HRW wheat contract can be found in the CME Group's Special Executive Report 7923 (CME Group 2017). As Garcia, Irwin, and Smith (2014) explain, shipping certificates allow the regular facility a higher level of flexibility with their physical storage because, unlike warehouse receipts, they do not require the issuing regular facility to maintain the grain in storage, thus the number of outstanding shipping certificates is not limited by storage capacity. However, if the holder of the shipping certificate demands load-out, the regular facility that issued the shipping certificate must source the grain within a specified period.

Grain handling facilities must meet the requirements laid out in rule 703 of the CBOT rulebook in order to become a regular facility (CME Group 2018). The regular facilities in the HRW wheat contract are located within the switching limits of Kansas City, Hutchinson, Salina/Abilene, and Wichita. Only regular facilities can create new delivery instruments; however, as Irwin et al. (2011) explain, if other shorts are holding a delivery instrument, either through purchasing an outstanding delivery instrument or from being delivered upon previously, they can also initiate the delivery process.

The load-out process converts delivery instruments into physical grain and links the futures and cash prices. When a long demands load-out, the regular facility that issued their delivery instrument mixes, grades, and loads the grain according to the long's instructions, which, as Irwin et al. (2011) explain, inflates demand in the cash market and raises the cash price. The long pays a load-out fee to cover the costs of load-out to the regular facility and is responsible for the transportation of the grain after the load-out process. The costs of load-out attributes to the costs of delivery against the futures contract. Irwin et al. (2011) calculated the cost of delivery to be 8 cents per bushel for all CBOT grain contracts based on a 6-cent barge load-out fee, and a 2 cent fee for other costs including grading and blending the grain.

Adjemian et al. (2013) attributes the lack of convergence in grain futures markets to the disconnect between storage rates for the physical commodity and the storage rates for the delivery instrument specified in the commodity's contract. Delivery instruments can be held indefinitely if daily storage fees are paid in accordance to rule 14H08, located in the KC HRW Wheat Futures chapter of the CBOT rulebook (CME Group 2018). Prior to the MAR '18 contract, the storage rate on warehouse receipts was fixed, albeit with a seasonal adjustment to account for storage availability concerns in the post-harvest contract months. This could lead to the creation of a "wedge" between the cost of physical storage and the cost of storing a delivery instrument, as demonstrated by Garcia, Irwin, and Smith (2014). Their study found a strong positive correlation between the wedge and ending stocks at delivery locations, implying that the lack of available physical storage can lead to nonconvergence. Figure 2 shows how a lack of available storage can create a wedge in the short run. At $S_0$, the storage market is in equilibrium, where the price of physical storage is equal to the cost of storage for the delivery instrument. If the supply of available storage decreases, ceteris paribus, the cost of physical storage will increase; however, because delivery instrument's storage rates are fixed by the CBOT, the cost of physical storage now exceeds the cost of storing the delivery instrument. Holders of delivery instruments are incentivized to store their delivery instruments rather than going through the load-out process and storing the physical commodity. Thus, a disconnect between the cash and futures market is probable. The CBOT has recognized the inefficiencies caused by fixed storage rates on the delivery instruments and implemented a variable storage rate (VSR) in the soft red winter (SRW) wheat contract in 2010 and more recently in the HRW wheat contract in 2018. The VSR adjusts the storage rate on shipping certificates to align with the cost of carrying the physical grain.

## THEORETICAL MODEL

While the causes of nonconvergence at delivery locations are well documented, the effects of nonconvergence on cash prices at non-delivery locations are under-researched, especially for the HRW wheat contract. Karali, McNew, and Thurman (2018) modeled basis at non-delivery locations around Toledo, Ohio, as a percentage of basis at the delivery location for SRW wheat plus a location-based fixed effect to account for transportation costs and local supply and demand factors from the MAR '05 contract through the MAY '13 contract. This allowed them to determine the rate of basis movement at non-delivery locations relative to the delivery point. For the contract months analyzed by Karali, McNew, and Thurman (2018), there was only one period of nonconvergence; from the MAY '08 to the DEC '09 contracts. The CBOT introduced the VSR mechanism in the SRW wheat contract in 2010; after which, nonconvergence was not present. As a result, Karali, McNew, and Thurman (2018) analyzed three time periods: pre-nonconvergence, nonconvergence, and post-nonconvergence. They found that during periods of nonconvergence, on average, basis at non-delivery locations follows changes in basis at the delivery location more closely than the previous period of convergence, signaling a disconnect of futures and cash prices throughout the studied area. Moreover, in the post-nonconvergence period, basis co-movement decreased to levels similar to the pre-nonconvergence period.

## DATA

Daily cash closing prices, from Jan. 2, 2004, to July 13, 2018, were collected for #1 hard red winter wheat at 90 grain handling facilities from DTN's ProphetX database. The prices represent the amount the elevator is willing to pay per bushel of #1 HRW wheat and do not include any premiums or docks for qualities such as moisture levels and protein. These locations were chosen based on data availability and represent five regular facilities in delivery locations Salina, Abilene, and Hutchinson; two non-regular facilities in delivery locations Hutchinson and Wichita; USDA daily grain bids for Dodge City, Garden City, Goodland, and Kansas City, Missouri; and 79 elevators in non-delivery locations throughout Kansas. The selected locations for cash prices are clustered more densely in the central part of the state where production of HRW wheat is highest, as shown in Figure 3. Wheat production numbers are based on NASS statistics from 2004–2017 (USDA-NASS 2018). Observations with missing prices were removed from this study resulting in an uneven panel data set.

Basis for each location was calculated by subtracting the nearby futures price from the respective cash price for each day and is measured in dollars per bushel. Kansas City was chosen as the base for comparisons over the other delivery locations because of its barge loading facilities on the Missouri River and the ease of transport to the Gulf of Mexico for export. Deliveries at Kansas City occur at the par value of the contract, as shown in rule 14H05 in the KC HRW Wheat Chapter of the CBOT Rulebook (CME Group 2018). To determine the periods of nonconvergence, the average basis at Kansas City during the delivery period of each contract was calculated. Regarding the load-out costs, estimated at $0.08 by Irwin et al. (2011), any contract with an average delivery period basis at Kansas City less than 8 cents under par value is considered nonconvergent. Only cash-under-futures nonconvergence is considered because of its pervasive nature in the analyzed period. Of the 73 studied contracts, 44 contracts exhibited nonconvergence. The average basis at Kansas City during the delivery period is plotted in Figure 4. Points below the orange line denote nonconvergence.

## EMPIRICS

A model was developed to calculate expected basis at each location, given basis in Kansas City the previous day. Hauser, Garcia, and Tumblin (1990); Taylor, Dhuyvetter, and Kastens (2006) determined that expected basis can be modeled adequately using naïve pricing, further supporting its use in this study. The model used to find expected basis is given by:

(1) $$b_{ikt} = FE_i + CM_j + \delta_i b^{KC}_{kt-1} + \gamma_i D^{nonconvergence}_k$$

Where:

$i$= 1, ... , 90 (grain handling locations)

$j$= 1, ... , 5 (nearby contract month, i.e. March, May, July, September, December)

$k$= 1, ... , 73 (all contracts from March 2004–July 2018)

$t$= 1, ... , 3250 (date)

The dependent variable, represented by $b_{ikt}$, is equal to the basis ($/bu) at location i for contract $k$ on day $t$. $FE_i$ represents the fixed effects for location $i$. $CM_j$ is a dummy variable for the contract month $j$ to control for seasonality differences in basis. $b^{KC}_{kt-1}$ is the basis ($/bu) at Kansas City for contract $k$ on day $t$-1. Basis at Kansas City is lagged to allow the various locations to react to a change in basis at the delivery location using the assumption that elevator managers look at basis in Kansas City at the end of the day and adjust basis at their location accordingly. $D^{noncon}_k$ is a dummy variable denoting the presence of nonconvergence in contract $k$. The coefficient $\delta_i$ measures the basis at location i as a percentage of basis at Kansas City. The coefficient $\gamma_i$ measures the change in basis at location i when nonconvergence is present.

Location-based fixed effects were included in the model to account for transportation cost differentials and local supply and demand factors. The location-based fixed effect allows for a fair comparison of the basis co-movement values between locations. Kansas City is the base value with which the rest of the locations are compared. Therefore, the fixed effects coefficients can be thought of as the expected basis at location $i$ given basis at Kansas City is equal to zero during any given July contract.

The contract month dummy variable controls for seasonal patterns in basis and prevents biasing the effects of nonconvergence. The July contract is omitted to be used as the base because of its temporal alignment with the majority of HRW wheat harvest throughout the state. The cyclical nature of grain production, in conjunction with supply and demand, theoretically dictates that local basis will be weakest during or immediately after harvest. The increased supply of grain following harvest will depress local prices, thus weakening basis. As grain is moved from the location, supply will dwindle, and local basis should strengthen until the next harvest.

The basis co-movement coefficient measures the magnitude of a change in basis at location i as a percentage of a change in basis at Kansas City the previous day. In a period of convergence, the rate of change in basis at location $i$ given a change in basis in Kansas City is equal to $\delta_i$ . Therefore, the expected basis during a period of convergence at location $i$ given a change in basis in Kansas City the previous day can be determined using the formula:

(2) $$Eb_{ikt} = b_{ikt-1} + \delta_i * \Delta b^{KC}_{kt-1}$$

The most interesting coefficient is the change in basis because of nonconvergence. This coefficient will explain how basis at non-delivery locations is affected by nonconvergence. In a period of nonconvergence, the expected change in basis at location i given a change in basis at Kansas City can be calculated using the formula:

(3) $$\Delta b_{ikt} = \delta_i * \Delta b^{KC}_{kt-1} + \gamma_i$$

Lastly, the expected basis during a period of nonconvergence at location i given a change in basis in Kansas City the previous day is calculated using the formula:

(4) $$Eb_{ikt} = b_{ikt-1} + \delta_i * \Delta b^{KC}_{kt-1} + \gamma_i$$

## RESULTS

The model shown in Equation 1 is estimated using OLS regression with White-Huber standard errors to account for heteroskedasticity present in the data set. A summary of the regression results is shown in Table 1. Full results are available from the authors upon request. As expected,

$CM_j$, summarized in Table 2, shows that basis is expected to be weakest during the July contract months, reinforcing the theory that basis is weakest during and immediately following harvest. On average, basis is expected to be $0.048 per bushel higher for a contract other than the July contract. The rest of the coefficients are then matched to their respective locations. These values are then interpolated across space using the kriging method and discussed through Figures 5–9 below.

Figure 5 shows the interpolated results for the fixed effects coefficients. These values can be interpreted as the expected difference between basis at each location and basis at Kansas City. The highest values of fixed effects are clustered around delivery locations and decrease as the distance to the closest delivery location increases. The inverse relationship between the expected difference in basis and distance to a delivery location demonstrates the theory that transportation costs to a delivery location are a major factor in determining cash prices in outlying markets. Moreover, the difference in fixed effects between a regular facility and a non-regular facility in the delivery location of Hutchinson, Kansas, is $0.18 per bushel, indicating that regular facilities offer a higher cash price than their non-regular counterparts.

For each studied location, basis as a percent of Kansas City's basis is significantly greater than 0 and significantly less than 1, with a range between 72.5 percent and 92.1 percent. This suggests that the rate of basis change in outlying locations has the same direction of change as basis at Kansas City, but at a reduced rate. When analyzed spatially, shown in Figure 6, the northern half of the state exhibits higher rates of co-movement with Kansas City's basis than the southern half. This implies Kansas City is the most convenient barge load-out facility for the northern areas of the state, while the southern areas look elsewhere, most likely Tulsa, Oklahoma. Thus, it is sensible to assume that the southern parts of the state would exhibit a weaker connection to basis changes in Kansas City than areas that haul grain to Kansas City to be loaded for export.

Nonconvergence was estimated to have an effect on basis between −$0.121 and $0.005 per bushel. Figure 7 displays the effects of nonconvergence on basis in dollars per bushel. It is readily apparent that nonconvergence had a lesser effect on basis at locations near delivery points in the middle of the state, suggesting that the shortage of available storage that created nonconvergence in Kansas City does not necessarily mean nonconvergence is occurring in other delivery locations. Figure 8, using data collected by the Arthur Capper Cooperative Center, shows storage capacity of grain handling facilities, both cooperative and noncooperative, in Kansas by county. Storage capacity is largest in the area where nonconvergence had the least effect on basis. The larger storage capacity in this area should minimize storage availability concerns and dampen the cause of nonconvergence. When nonconvergence is present at Kansas City, 50 of the 90 locations studied exhibited a statistically significant decrease in expected basis. Figure 9 displays a Bayesian krig of the significance of the effect on nonconvergence on basis. The results from the Bayesian krig can be interpreted as the probability that nonconvergence has a significant effect on basis. Unsurprisingly, the areas that exhibited the lowest effect of nonconvergence were also least likely to exhibit a statistically significant impact on basis. Areas with a low probability of significance are unlikely to observe an effect on basis attributed to nonconvergence.

## IMPLICATIONS

The purpose of this study was to inform farm managers of spatial patterns in factors influencing basis across the state of Kansas. Geospatial mapping of cross-sectional time series data demonstrated how basis patterns varied across the state. Naïve pricing allows producers to easily calculate expected changes in basis with readily available data to improve their marketing strategies. This study reaffirmed the economic theory that basis is linked to transportation costs by analyzing the location-specific fixed effects. Though this is not new information, it helps explain the price disparity between locations throughout the state. Similarly, nonconvergence has a lessened effect on basis in areas with more grain storage and locations near delivery locations. This is likely part of the explanation behind the weaker connection to Kansas City's cash prices of study locations in the southern half of the state compared to those in the northern half. Geospatial analysis gives a more comprehensive understanding of the effects of nonconvergence than the stand-alone results and helps producers make more informed decisions about grain marketing.

Farm managers can use the results of this study in discussions with their producers to help them understand the historical movement of basis and trends regarding location and delivery month. The geospatial mapping, shown in Figures 5, 6, and 7, allows for basis predictions to be tailored to the producer's specific locale. In areas where nonconvergence is likely to have an effect on basis, shown by the green areas in Figure 9, farm managers should prepare for a wider spread between Kansas City's price and their local price when nonconvergence is occurring, resulting in weaker-than-normal basis. This could create an opportunity for producers to gain a higher realized price through basis improvements with a storage hedge, for example, if the markets converge in a timely matter; however, depending on the producer's risk preference, basis risk from the increased volatility could offset any potential gains in basis improvement. Producers should also be cognizant of the risk of nonconvergence beginning while they are entered into a storage hedge, which could result in lower than expected basis improvements and a lower realized net price.

It is important for all users of both cash and futures markets to understand the underlying price and/or basis risk they may be facing. Using the results from this study, producers and farm managers can better predict changes in their local basis and adapt their marketing strategies to fluctuating market conditions. Future work will be done in this area to examine the impact of variable storage rates and the shift to shipping certificates on the hard red winter wheat futures market.

## REFERENCES


Adjemian, Michael K., Philip Garcia, Scott Irwin, and Aaron Smith. 2013. *Nonconvergence in Domestic Commodity Futures Markets: Causes, Consequences, and Remedies* U.S. Department of Agriculture, Economic Research Service. http://webdoc.agsci.colostate.edu/koontz/arec412/Resources/eib115.pdf.

Arthur Capper Cooperative Center. *Cooperative and Noncooperative Grain Locations in Kansas*. 2017. http://accc.k-state.edu/map.html.

CME Group. 2017. "Amendments to CBOT Chapters 7, 14H, and 14N in Connection with the Implementation of Variable Storage Rate and Migration of Delivery Rules for KC HRW Wheat Futures Contracts." Special Executive Report, SER#7923. https://www.cmegroup.com/content/dam/cmegroup/notices/ser/2017/05/SER-7923.pdf.

CME Group. 2018. "CBOT Rulebook." https://www.cmegroup.com/rulebook/CBOT/.

Garcia, Philip, Scott H. Irwin, and Aaron Smith. 2014. "Futures Market Failure?" *American Journal of Agricultural Economics* 97 (1): 40–64. doi:10.1093/ajae/aau067.

Hauser, R. J., P. Garcia, and A. D. Tumblin. 1990. "Basis Expectations and Soybean Hedging Effectiveness." *Applied Economic Perspective and Policy* 12 (1): 125–136. doi:10.1093/aepp/12.1.125.

Irwin, Scott H., Philip Garcia, Darrel L. Good, and Eugene L. Kunda. 2008. "Recent Convergence Performance of CBOT Corn, Soybean, and Wheat Futures Contracts." *Choices* 23 (2): 16–21.

Irwin, Scott H., Philip Garcia, Darrel L. Good, and Eugene L. Kunda. 2011. "Spreads and Nonconvergence in Chicago Board of Trade Corn, Soybean, and Wheat Futures: Are Index Funds to Blame?" *Applied Economic Perspectives and Policy* 33 (1): 116–142. doi:10.1093/aepp/ppr001.

Karali, Berna, Kevin McNew, and Walter N. Thurman. 2018. "Price Discovery and the Basis Effects of Failures to Converge in Soft Red Winter Wheat Futures Markets." *Journal of Agricultural and Resource Economics* 43 (1): 1–17.

Taylor, Mykel R., Kevin C. Dhuyvetter, and Terry L. Kastens. 2006. "Forecasting Crop Basis using Historical Averages Supplemented with Current Market Information." *Journal of Agricultural and Resource Economics* 31 (3): 549–567.

USDA-NASS. 2018. Quick Stats. https://quickstats.nass.usda.gov/results/DB9626B9-3474-3CEB-8FD4-098D874245C3.


## APPENDIX

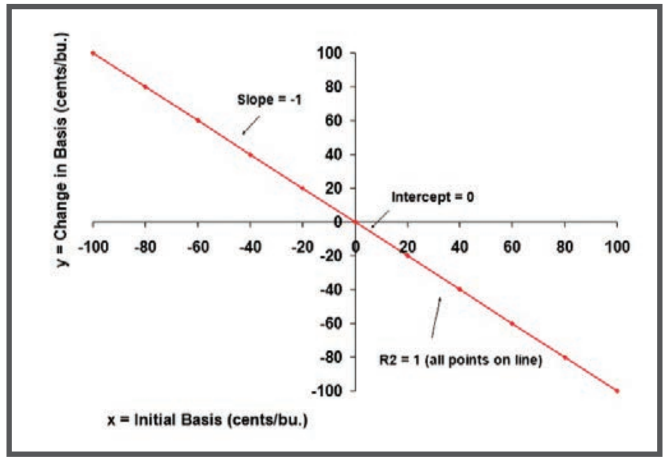


Figure 1. Perfect Basis Predictability

Source: Irwin et al. (2008)

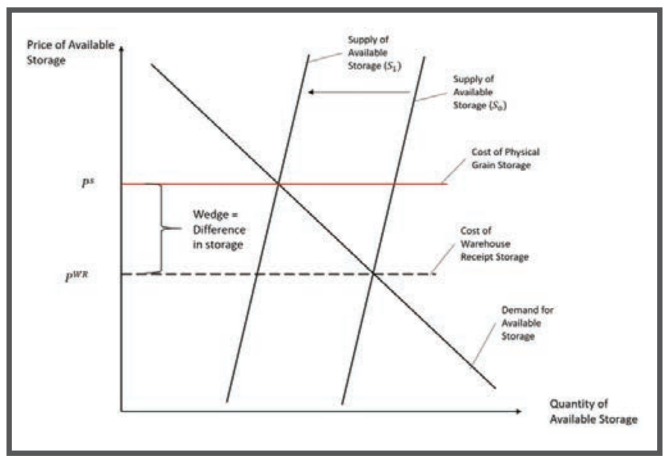


Figure 2. Wedge Creation from Lack of Available Physical Storage

Source: Irwin et al. (2008)

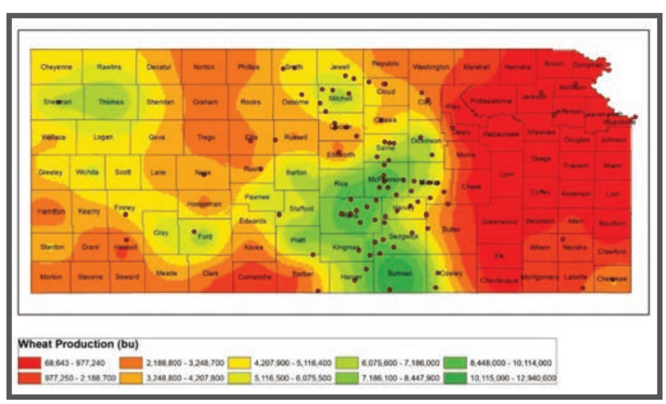


Figure 3. Average HRW Wheat Production, 2013–2017

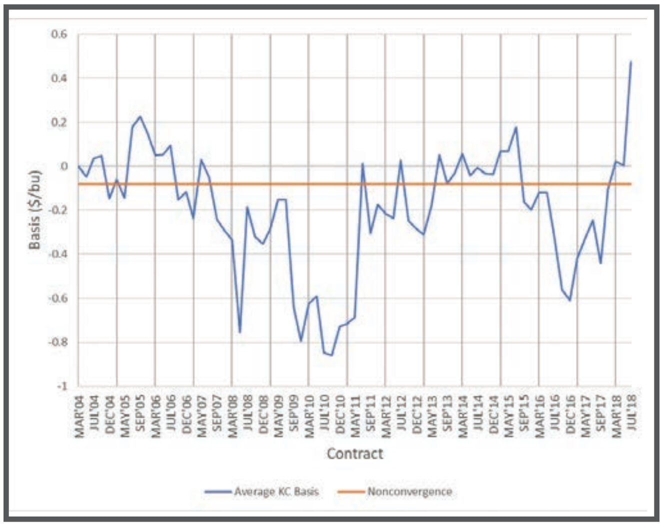


Figure 4. Average HRW Wheat Basis During the Delivery Period at Kansas City, MO

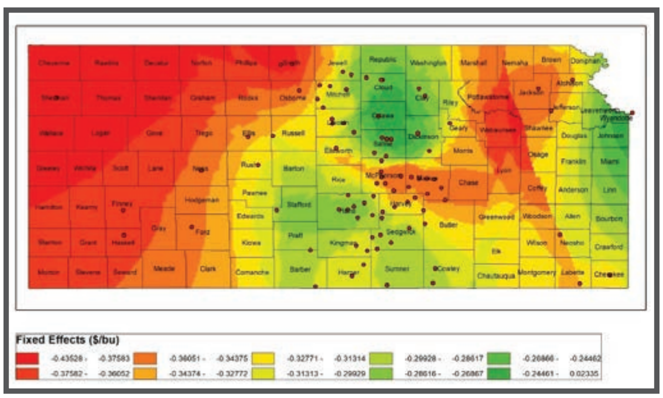


Figure 5. Fixed Effects

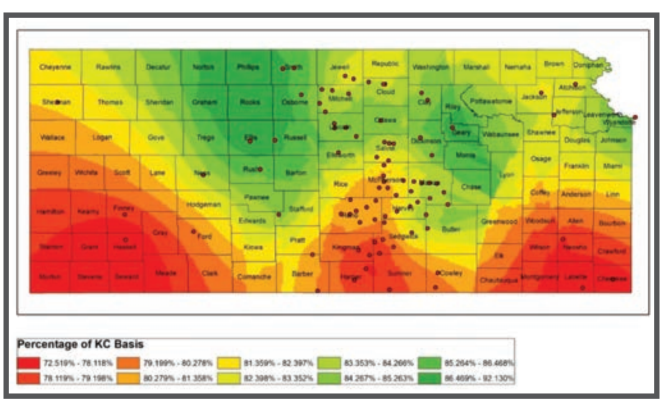


Figure 6. Basis as a Percent of Kansas City, MO Basis

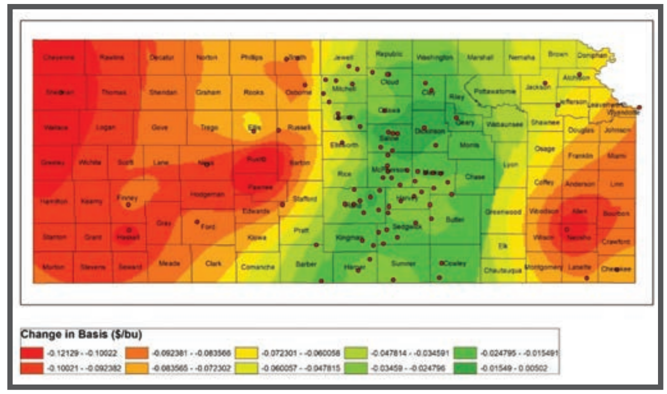


Figure 7. Effect of Nonconvergence on Basis

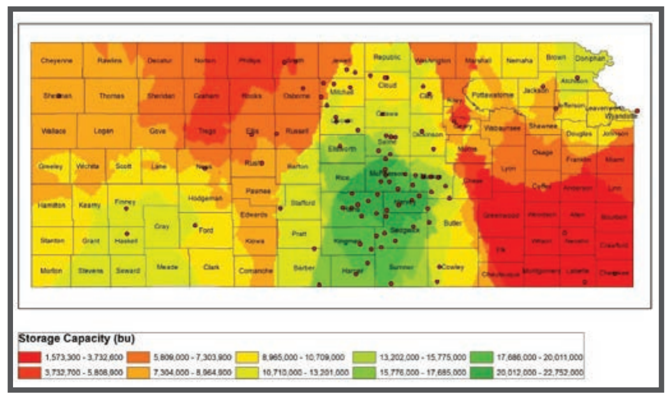


Figure 8. Grain Storage Capacity

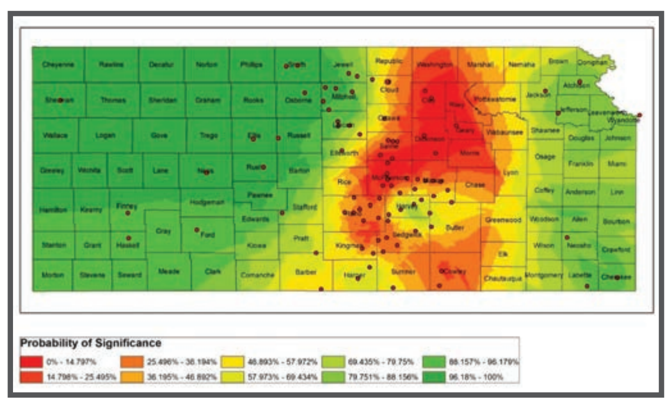


Figure 9. Significance of Effect of Nonconvergence on Basis

**Table 1. Summary of Regression Results**

| | Coefficients | | | |
|---|---|---|---|---|
| | **Fixed Effects** | **Contract Month** | **Comovement** | **Nonconvergence** |
| n | 89 | 4 | 90 | 90 |
| Mean | -0.31418 | 0.04809 | 82.375% | -0.03802 |
| Min | -0.43528 | 0.02285 | 72.519% | -0.12129 |
| Max | 0.02335 | 0.06310 | 92.130% | 0.00502 |
| 10th percentile | -0.37478 | 0.03184 | 78.087% | -0.08371 |
| 90th percentile | -0.26169 | 0.06025 | 87.168% | -0.01688 |
| **Counts:** | | | | |
| Significantly >0 | 1 | 4 | 90 | 0 |
| Significantly <0 | 88 | 0 | 0 | 50 |
| Number >0 | 1 | 4 | 90 | 1 |
| Number <0 | 88 | 0 | 0 | 89 |
| Significantly =/=0 | 89 | 4 | 90 | 50 |

Prob > F = 0
R-squared = 0.9008

**Table 2. Seasonality of Basis**

| Contract Month | Coefficient | Standard Error | t-value | P-value |
|---|---|---|---|---|
| March | 0.0630998 | 0.0011379 | 55.45 | 0 |
| May | 0.0535986 | 0.0011762 | 45.57 | 0 |
| July | 0 | N/A | N/A | N/A |
| Sep | 0.0228501 | 0.001253 | 18.24 | 0 |
| Dec | 0.0528253 | 0.0011415 | 46.28 | 0 |

# Old Order Amish Settlements and New York Farmland Markets

**By Jennifer Ellen Ifft and Yawen Gao**

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We are grateful to Caren Kay and Melanie Bruce for construction of the farmland sales data set. Bob Morabia, Jacob Freedland, and Angelo Manzo provided research assistance in locating Amish districts. Bruce Berggren-Thomas, Marty Schlabach, and Judson Reid provided valuable insights into New York Plain and Anabaptist communities. Nelson Bills provided research advice and encouragement for this project. We are grateful to several rural appraisers from New York state whose discussion of Amish influence on farmland markets motivated this work. This work was also supported by the USDA National Institute of Food and Agriculture, Multistate project 1007199.

## Abstract

*Affordable farmland has been a major factor fueling population growth among the horse-and-buggy driving population in New York. To better understand this relationship, we used a directory of local Amish church leadership to approximate the location of nearly all New York Old Order church districts from 1999 to 2015. The centroid of all addresses associated with each district's leadership was matched to New York farmland sales transactions within a 10-mile radius from the same period. We then conducted a trend analysis of farmland prices with and without Amish influence in four regions of New York state. We find that having a nearby Amish district was associated with lower prices at the state level but not necessarily the region level, and prices generally grew at a similar but slightly lower rate for farmland with nearby Amish districts. In some regions, farmland with a higher density of nearby Amish districts experienced higher growth in sale prices. Further, soil quality of transacted parcels doesn't have a consistent relationship with proximity of an Amish district.*

## INTRODUCTION

New York has approximately 16,000 Old Order Amish church members living in 120 districts, the fifth-largest population after Pennsylvania, Ohio, Indiana, and Wisconsin (Elizabethtown College, 2017). The Old Order Amish emphasize family and community ties and living separate from the modern world. In order to minimize their involvement with external society, farming has become their main way of protecting their religion and culture as well as the main driver of their economy (Johson-Weiner, 2010). Many Old Order Amish in New York came from Pennsylvania and Ohio to look for cheaper farmland (Johson-Weiner, 2010; Reid, 2015). The agricultural lifestyle of the Old Order Amish has been maintained in many of their New York settlements (Amish America, 2014). Their growing role of the Amish in New York agriculture, as well as agriculture in many other states, motivates our analysis of Amish population and farmland markets.

Farmers, rural appraisers, and other farmland market observers often report that Amish communities usually purchase relatively lower-valued land, but that over time they compete for land with conventional producers. "Amish influence" is a commonly mentioned driver of farmland value growth and market activity in New York. Another anecdote is that "conventional farmers" have to increase their profitability to compete with Amish for farmland. However, we know of no empirical analyses of the role of Amish in farmland markets. Past studies have largely focused on Amish farming practices and demographic changes. After a brief description of Amish farming practices, we describe how we approximated the location of these communities and matched them with farmland transactions data. Next, we conduct a basic trend analysis of farmland prices around Amish settlements. This study tests some of the "conventional wisdom" about Old Order Amish population growth and also provides an empirical foundation for future work in this area.

## AMISH FARMING PRACTICES

Few remaining traditional farming societies still exist in the United States, and the Old Order Amish is one of the most representative. While Amish farming has evolved over time, Amish farming is notably different from modern or conventional agriculture. Use of horses and mules instead of tractors is one of their most well-known farming traditions. The use of horses not only guarantees Amish people's participation in farm labor but also provides an important source of fertilizer by producing manure. As a result, most Amish farms are small-scale; usually between 60 and 100 acres because of the limitations imposed by using human and animal labor (Zook, 1994).

Even though Amish communities usually try to avoid using recent technologies, some innovations such as mechanical milkers, veterinary services, pesticides, and artificial cattle insemination have been selectively adopted by some communities after consideration of the impacts on Amish religion and way of life.

Amish farming is characterized by a diversity of crop and livestock production activities. Depending on community activities and family interests, Amish farmers might grow wheat, corn, alfalfa, hay, tobacco, vegetables and fruits; have herds of milk cows; or raise poultry, cattle, mules, and horses. As most of what is fed to animals is grown on the farm, they produce more types of grain and maintain a more frequent crop rotation than non-Amish farmers. A common rotation employed by Amish farmers is a three-year cycle of corn-oats-hay, with the main difference from the non-Amish being the inclusion of oats into crop rotations to provide feed for horses (Blake et al, 1997).

Small-scale production and diverse land use patterns illustrate the primary focus of Amish agriculture — self-sufficiency. In lieu of expanding production to better their economic conditions, Amish farmers focus on generating outputs sufficient to allow them to live consistently with their beliefs. Self-sufficiency and labor-intensive farming minimize their need for more agricultural inputs and capital. Therefore, Amish farmers are relatively more independent from external markets and have less reliance on lenders. With generally lower living and production expenses, Amish farmers are able to easily keep money within their communities and seldom suffered the financial stresses that put a large number of non-Amish farmers out of business in the early 1980s (Logsdon, 1988).

Major Amish settlements in New York include Conewango Valley, Heuvelton, Clymer, and Mohawk Valley. Affordable farmland has provided an opportunity for the Amish in New York to maintain an agrarian lifestyle, including traditional farming, traditional handicrafts, and raising livestock. Livestock and horse auctions are popular events. Dairy farming is a major economic activity in many New York Amish settlements, with many Amish farmers supplying milk to local cheese factories (Amish American, 2014; Johson-Weiner, 2010). Amish society is largely organized in settlements and church districts. "Settlement" describes the geographical location where a group of Amish people live. A typical church district is led by its own ministry (randomly selected bishop, elders, and deacons) and contains approximately 30 Amish families. When a district becomes too large (approximately 40 families), it usually splits into separate districts. We use church district to approximate the level nearby Amish population in this study.

## DATA AND APPROACH

To approximate the location of Old Order Amish districts, we use a similar approach as Wilson, Lonabocker, and Zagorski (2016), who used the published addresses of Amish church district leadership from the *The New American Almanac* (commonly referred to as Raber's Almanac) as a proxy measure for the distribution of the Amish population across Ohio and Pennsylvania. In brief, the address of church district leadership was entered into geo-locating software to search for the nearest residence that showed characteristics associated with the Amish. Their research produced a fine-scale map of the density of Amish settlements in these two states. While their objective was to locate Amish households, our goal was to approximate the location of each church district. Some similar disclaimers apply however, such that we do not have comprehensive population data and that there may be errors in addresses or missing information from Raber's Almanac.

There are some practical considerations for future replications of our approach. Addresses from Raber's Almanac can be scanned and converted to tabular (Excel) format, but additional data cleaning is essential, as well as knowledge of Amish settlement patterns and farming. While some addresses were incomplete or incorrect in earlier years, they could be matched with completed addresses from later years or fixed through simple investigation in Google Maps. In a handful of cases, we could not locate all addresses, so relied on fewer addresses (usually at least two) per district to calculate the centroid. When we entered some incorrect or incomplete addresses into geo-locating software, some incorrect coordinates were generated. We were usually able to fix these through visual inspection on ArcGIS and Google Maps. Further, district names often change in trivial ways between years, such as the addition of a year to the district name. Some districts appeared to be missing in certain years, so we added them to our data set if they were listed in Raber's Almanac in previous and subsequent years. In summary, digitizing and geo-locating these addresses requires careful, methodological attention to detail.

There were usually three addresses for leadership/ministers of each Amish church district, ranging from two to five. We matched the centroid of leadership addresses from 1999–2015 with farmland sales from the same period. Farmland sales data were provided by the New York Office of Real Property Tax Services. Sales price is calculated by dividing total sale price by total sales acres for each transaction. All land classified as agricultural (codes 100–199) is used in our study, although we do drop sales of less than 1 acre or more than 5,000 acres. We similarly drop sales less than $50 per acre or more than $20,000 per acre. Farmland sales in suburban counties and Long Island are dropped because of insufficient observations. More details on this data set can be found in Bigelow, Ifft, and Kuethe (2017). For each farmland parcel sold during our study period, we count the number of Old Order Amish districts within a 10-mile radius from 1999–2015. We then estimate a linear trend for each parcel and use the fitted values for number of districts to account for population growth. That fitted value is believed to best describe the current Amish population near the parcel when it was transacted.

We first conduct a simple analysis at state level, looking at price trends between parcels with and without Amish settlements with a 10-mile radius (which we also refer to as "nearby" or Amish influenced). Then we remove counties that had no Amish districts, to have a more comparable set of farmland transactions. There are few Amish districts in the Hudson Valley and Capital regions of New York, which also face higher levels of development pressure. The second part of the trend analysis is conducted at the regional level. Based on the larger patterns of Amish settlement, counties with Amish districts are broken down into four regions across the state: Western NY, Finger Lakes, Central NY, and St. Lawrence Valley. A handful of relatively isolated districts are not included within any of these four regions. We further exclude Yates County, which has a large Old Order Mennonite population (Reid, 2015). The annual increase in number of Amish districts near a transacted parcel is calculated to represent the growth rate of Amish settlements in each region. In addition, we divide parcels in each region into four groups or quartiles, according to number of nearby Amish districts.

We also evaluate soil quality of parcel sold, to understand whether (1) Amish are purchasing lower quality land and (2) whether soil quality could explain the price differential between land with and without Amish influence. Soil quality is based on two measurements, the first of which is the New York Soil Group number. This is a soil quality index developed specifically for taxation of agricultural land in New York state and is based on productivity for corn and hay production (New York State Department of Agriculture and Markets, 2017). Soil Group Numbers range from 1 to 10, with 1 being the highest quality and 10 being the lowest. The second measurement is National Commodity Crop Productivity Index (NCCPI), which expresses the inherent capacity of the soils in a given field to produce commodity crops. The NCCPI uses a scale of 0 to 1, with 0 having a lower productivity potential and 1 higher potential (USDA NRCS, 2012).

## RESULTS AND DISCUSSION

One of the main objectives of this study is to locate the Old Order Amish population in New York and match their location to farmland sales. Figure 1 shows all farmland sales in New York from 1999–2015. Parcels within 10 miles of an Amish district are shown in colors, with region (see previous section) indicated in the legend. Most of the Old Order Amish are concentrated in the Chautauqua-Allegheny region in Western New York, the middle area of the Finger Lakes region, northern New York (centered around St. Lawrence County), and Mohawk Valley (central New York). Areas without farmland sales represent urban areas, the Adirondack National Forest (northern New York), and the Catskills (Hudson Valley/southeast New York).

Figure 2 shows the average number of Amish districts near each farmland parcel that was transacted from 1999–2015. There was an average of 0.3 districts near each parcel sold in 1999 and 1.2 in 2015, indicating that the average number of nearby Amish districts increased by nearly 0.1 annually. This reflects the growing Old Order Amish population in New York during this period, as well as their growing influence on agriculture and farmland markets.

We next consider price trends in areas with and without Amish districts. Figure 3 shows the price of farmland with and without Amish settlements nearby. The size of the scatter plots reflects the relative acreage sold each year. The highest prices from 1999–2015 were for all parcels without any nearby Amish settlements, and the lowest prices were for parcels with nearby Amish districts. The prices for parcels with no nearby Amish districts reflect farmland sales in regions adjacent to New York City and Albany with little to no Amish population and higher levels of development pressure. Hence, we also consider parcels with no nearby Amish districts that are located in counties that also have parcels with nearby Amish. While still having lower prices than all non-Amish influenced parcels statewide, this restricted set of parcels without Amish influence still is higher-valued than parcels with nearby Amish. For both the statewide and restricted set of parcels without Amish influence, mean prices are statistically different from Amish-influenced parcels at the 1 percent test level for all years, with the exception of the restricted set of parcels without Amish influence in 1999. This may reflect differences in soil quality, improvements, or nonagricultural influences. Overall, this finding is consistent with Amish communities settling in areas with cheaper farmland. We also observe a slightly lower but similar growth rate of farmland prices for farmland with Amish influence.

We conduct a similar analysis at the regional level in Figure 4. Despite the difference in price trends among regions, the price of parcels near Amish districts usually begins at a lower position and rises at a slightly slower rate, consistent with statewide trends from Figure 3. However, for most years in most regions, the price between parcels with and without Amish influence is not statistically different. This suggests that Amish may choose to settle in regions of New York with relatively more affordable farmland, but do not necessarily take the same approach within the regions where they are already settled. In addition, the Amish settlement growth rate in each region is indicated in Figure 4. It is difficult to relate this growth rate with either the price starting point or the growth of prices. For example, Western NY and St. Lawrence Valley share a similar growth rate of Amish settlements and farmland values in 1999, but farmland values grew at a fast pace in the Western NY. This likely reflects the stronger overall growth of the agricultural sector in Western NY.

The state and regional price analysis in Figures 3 and 4 only considered the presence of Amish districts but not the density of districts. In Table 1, we consider farmland growth trends by density of Amish districts. For each region, we created four quartiles of the number of nearby Amish districts for all parcels sold from 1999–2015. The first quartile for each region is no nearby districts and is hence larger than the other quartiles. Regional differences in price growth become more pronounced when separating sales by density of nearby Amish.

In all regions other than St. Lawrence, the highest price growth rates occurred within either the first or second quartile of Amish settlements among all regions. The differences probably reflect the diverse agriculture, recreation, and Amish settlement patterns in each region. Western NY has older and denser Amish settlements than other regions. The reason for the differences in Western NY is not apparent and could be the result unobservable factors, such as various improvements, between parcels with different levels of Amish influence. Central NY has a relatively newer Amish population, but an inconsistent relationship between Amish density and farmland sales price. The Finger Lakes region has growing farming and tourism sectors overall, as well as a relatively smaller Amish population. In this region, Amish density is negatively correlated with farmland sales price. St. Lawrence region overall has lower farmland prices and few alternative uses beyond agriculture. For this region, in areas with the highest levels of Amish density (Q4), Amish influence may play a large role in farmland price growth.

Many factors could be influencing the differences between sales prices for farmland with and without Amish influence. We conclude our analysis by considering whether the soil quality of farmland sold around Amish settlements is different. We use two measures of soil quality, New York Soil Group number (Table 2) and NCCPI (Table 3). Findings using both measures are consistent. For Western and Central NY, soil quality using both measures is statistically different for parcels by Amish influence. However, the magnitude of difference is generally small and lower for Amish-influenced parcels in Western NY and higher for Central NY. The difference in the Finger Lakes is only marginally significant, and there is no difference for St. Lawrence. Overall, these findings suggest that soil quality is not a major factor in prices differences for farmland with and without Amish influence.

## CONCLUSION

The growth of Old Order Amish settlements and their distinctive agricultural practices are changing New York agriculture. As such, the Amish are now major players in farmland markets in many parts of New York. This study demonstrates a methodology for mapping the distribution of Amish districts and linking Amish districts to farmland sales, which may be useful to rural appraisers and also have wider application beyond farmland markets. We conduct a basic analysis of farmland price trends by level of Amish influence from 1999–2015. We find that at the state level, parcels sold near Amish districts are on average cheaper than those distant from Amish districts, which is consistent with farmland affordability being a major consideration for Amish settlements. However, the growth rate of land near Amish population tends to be similar or slightly lower than land without Amish influence. The relationship between both density of Amish districts and soil quality with farmland values is inconsistent across regions and motivates future research using multiple regression analysis. Many unanswered questions remain, and we look forward to further in-depth analysis of Amish population growth using general farmland valuation models.

Similar to Wilson, Lonabocker, and Zagorski (2016), we would like to note that we hope to maintain a balance between better understanding the role of Amish communities in New York agriculture while respecting their desire to live separately from the "outside world." As such, we do not intend of make the addresses of church leadership publicly available but are happy to cooperate with researchers and appraisers to share our data and approach.

## FOOTNOTES

1. It is important to note that lower values for New York Soil Group number imply higher soil quality, while NCCPI is the opposite.

## REFERENCES

*Amish Population Change* 2012–2017. Young Center for Anabaptist and Pietist Studies,

Elizabethtown College. Elizabethtown, PA, 2017. https://groups.etown.edu/amishstudies/files/2017/08/Population_Change_2012-2017.pdf.

Blake, Katharine V., Enrico A. Cardamone, Steven D. Hall, Glenn R. Harris, and Susan M. Moore. "Modern Amish Farming as Ecological Agriculture." *Society & Natural Resources* 10, no. 2 (1997): 143–59.

Bigelow, Daniel P., Jennifer Ifft, and Todd Kuether. "The Compatibility of Farmland Sales and Opinion Survey Data." Working paper. Dyson School of Applied Economics and Management, Cornell University. Ithaca, NY, 2018.

Johnson-Weiner, Karen M. *New York Amish Life in the Plain Communities of the Empire State*. Ithaca: Cornell University Press, 2017.

"New York Amish." Amish America Why Don't Amish Serve in the Military Comments. Accessed August 10, 2018. http://amishamerica.com/new-york-amish/.

New York State Department of Agriculture and Markets (2017). How agricultural assessment values are determined. https://www.tax.ny.gov/research/property/assess/valuation/01ag.htm.

Raber, Aden. 1999–2015. The New American Almanac, 2000–2016. Baltic, NY: Raber's Book Store.

Reid, Judson. "Old Order Mennonites in New York: Cultural and Agricultural Growth." *Journal of Amish and Plain Anabaptist Studies* 3, no. 2 (2016): 212–21.

Stinner, Deborah H., M.G. Paoletti, and B.R. Stinner. "In Search of Traditional Farm Wisdom For a More Sustainable Agriculture: A Study of Amish Farming and Society." *Agricultural Ecology and Environment*, 1989, 77–90.

*User Guide for the National Commodity Crop Productivity Index* (NCCPI). Natural Resources Conservation Service, 2012.

file:///C:/Users/Dell/Downloads/NCCPI_user_guide%20(2).pdf.

Wilson, Andrew M., et al. "Online Mapping Tools for Geolocating Amish Settlements." *Journal of Amish and Plain Anabaptist Studies*, vol. 3, no. 2, 2016, pp. 202–211.

Zook, Lee. "The Amish Farm and Alternative Agriculture." *Journal of Sustainable Agriculture* 4, no. 4 (1994): 21–30.

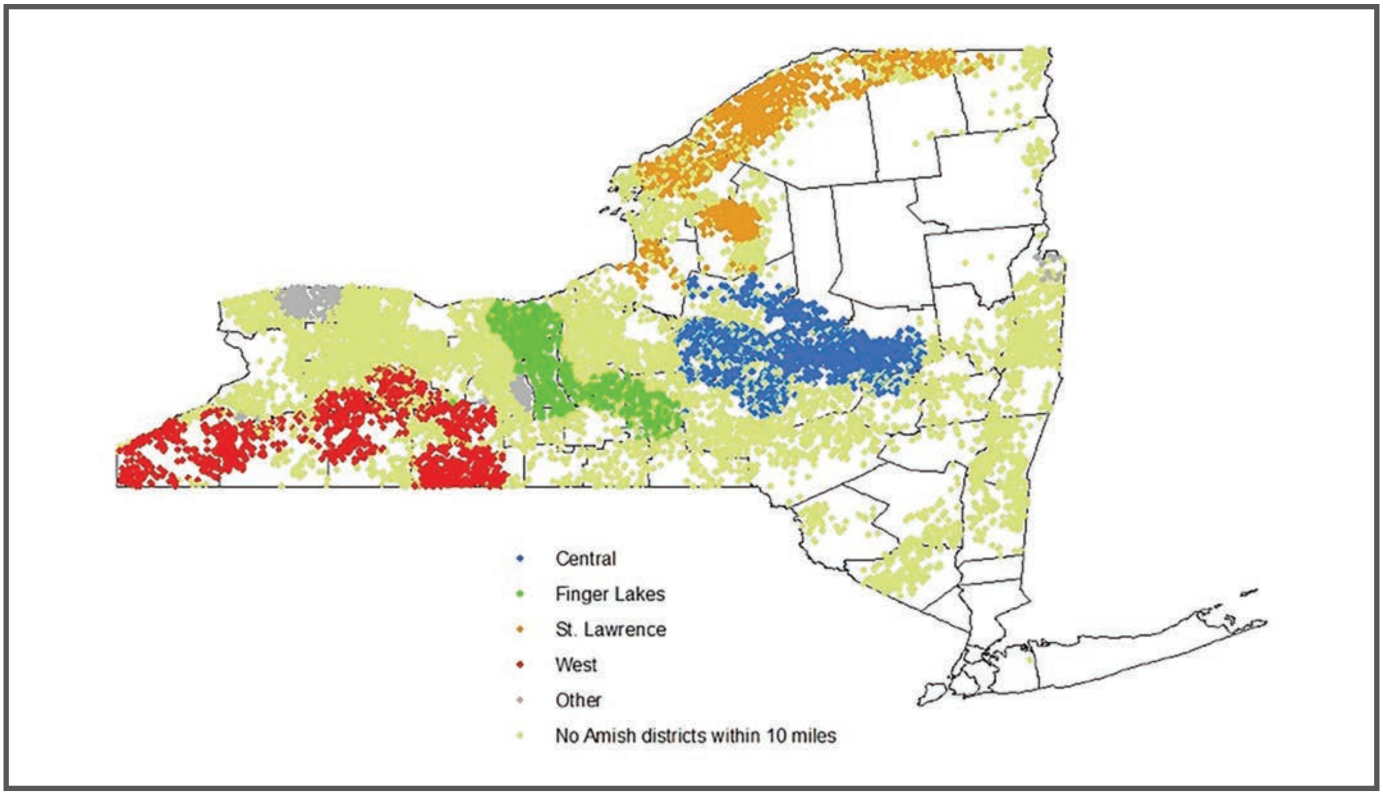


Figure 1: New York farmland sales with nearby Amish districts, 1999-2015

Note: All colored parcels are within 10 miles of an Old Order Amish district and grouped by relative geographic proximity (region), unless otherwise indicated. A district is a group of Old Order Amish families that live near each other and attend church together on a biweekly basis. “Other” refers to farmland near Amish districts that are relatively isolated or in Yates County, which has a large Old Order Mennonite population (Reid, 2015). Data on farmland sales are from the New York Office of Real Property Tax Service, and Amish district location is based on Raber’s Alamanc.

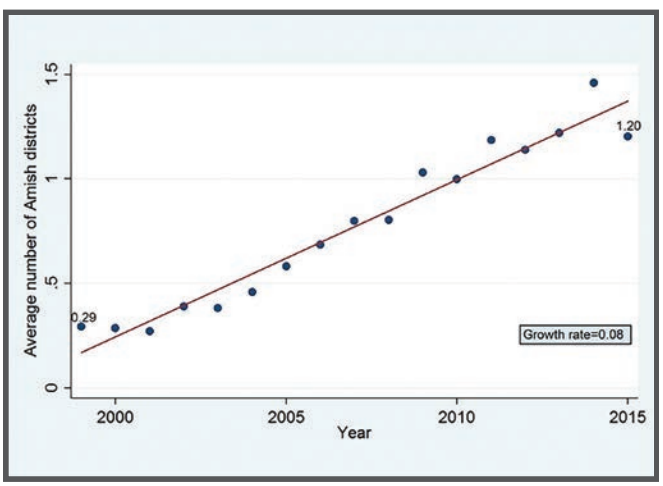


Figure 2: Average number of Amish districts located near New York farmland sales

Note: Average number of Amish districts within 10 miles of a farmland transaction

Source: New York Office of Real Property Tax Services and Raber’s Almanac.

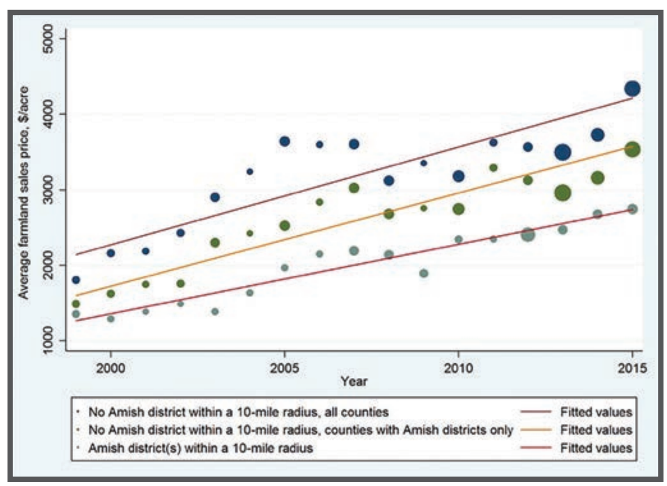


Figure 3: New York farmland prices by proximity of Amish districts, 1999 to 2015

Note: Scatter plot points are weighted by total acreage sold in each category.

Source: New York Office of Real Property Tax Services and Raber’s Almanac.

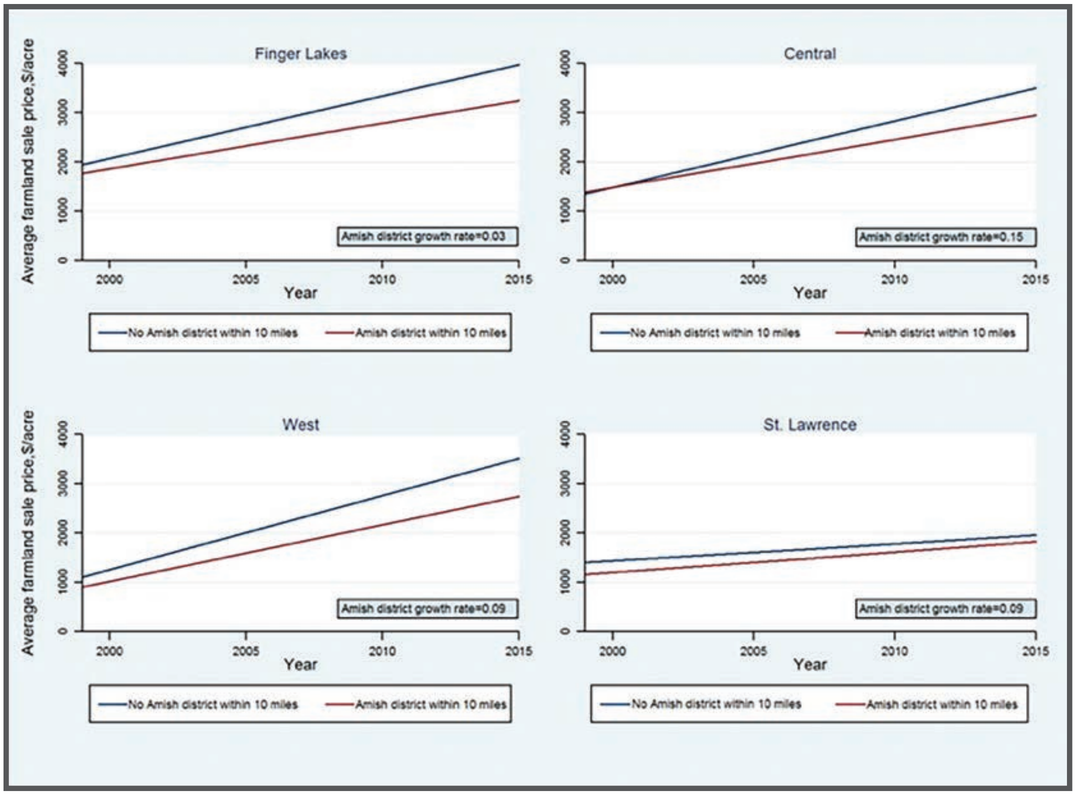


Figure 4: New York farmland prices by Amish influence and region, 1999–2015

Note: Region as indicated in Figure 1.

Source: New York Office of Real Property Tax Services and Raber's Almanac.

**Table 1: Annual farmland price growth rate by level of Amish Influence, 1999–2015 ($/acre/year)**

| | Amish District Quartile | | | |
|---|---|---|---|---|
| Region | Q1 | Q2 | Q3 | Q4 |
| Western NY | $128 | - | $122 | $111 |
| Central NY | $129 | $166 | $80 | $109 |
| Finger Lakes | $134 | - | $115 | $90 |
| St. Lawrence | $37 | -$29 | -$24 | $96 |

Note: We measure the number of Amish districts within a 10-mile radius of each parcel of farmland sold. Each quartile is based on dividing all farmland sales from 1999–2015 into four groups based on how many Amish districts are found near the sales. There is a larger number of parcels with no nearby Amish districts in Quartile 1.

Source: New York Office of Real Property Tax Services and Raber's Almanac.

**Table 2: Farmland soil quality by Amish influence**

| Region | Avg. NY Soil Group # | | T-Test Result | |
|---|---|---|---|---|
| | Without Amish Influence | With Amish Influence | T-value | Significance |
| Western NY | 5.5 | 5.7 | -2.95 | *** |
| Central NY | 5.5 | 5.3 | 2.85 | *** |
| Finger Lakes | 4.8 | 4.9 | -1.69 | * |
| St. Lawrence Valley | 4.5 | 4.4 | 1.27 | |

Source: New York Office of Real Property Tax Services, Raber's Almanac.

Note: A soil group number of 1 is the highest possible soil quality, 10 is the lowest. The t-statistic tests whether the difference between the NY Soil Group Number of parcels sold with and without Amish within a 10-mile radius equals zero. Single, double, and triple (*, **, ***) denote statistical significance at the 10%, 5%, and 1%, respectively.

**Table 3: Comparison between the NCCPI of parcels sold with and without Amish settlements nearby**

| Region | Avg. NCCPI | | T-Test Result | |
|---|---|---|---|---|
| | Without Amish Influence | With Amish Influence | T-value | Significance |
| Western NY | 0.4 | 0.38 | 4.13 | *** |
| Central NY | 0.38 | 0.45 | -17.22 | *** |
| Finger Lakes | 0.47 | 0.46 | 1.84 | * |
| St. Lawrence Valley | 0.35 | 0.35 | -0.75 | |

Source: USDA NRCS, New York Office of Real Property Tax Services, Raber's Almanac.

Note: For NCCPI, 0 is the lowest soil quality, 1 is the highest. The t-statistic tests whether the difference between the NCCPI of parcels sold with and without Amish within a 10-mile radius equals to zero. Single, double, and triple (*, **, ***) denote statistical significance at the 10%, 5%, and 1%, respectively.

# The Persistence of Grain Farm Returns in Illinois

**By Nicholas D. Paulson, Gary Schnitkey, and Dale Lattz University of Illinois**

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## Abstract

*Identifying factors affecting farm performance has long been a topic of interest to agricultural economists, farm operators, and managers. This article uses financial records from grain farms in Illinois to define peer groups among which to make multi-year performance comparisons. Results suggest that high-performance farms achieve both higher revenues and lower costs. The majority of the gap between high- and average-performance farms is due to revenues, while cost advantages are more important in separating average- and low-return farms. Efficient input selection, including labor and capital, seems to account for a significant portion of the return gap among farms.*

## INTRODUCTION

Over the past 10 years, returns on grain farms in Illinois and throughout the Corn Belt have changed dramatically. High commodity prices led to rising income and return levels from 2009 to 2012. Beginning in 2013, lower commodity prices have led to an extended period of declining return levels over the past five crop years, as production and land costs have remained relatively sticky. An important question facing farm operators is whether there exist management strategies that consistently result in success. In other words, is it possible to be a successful farm operator or manager across time, even when the various factors affecting returns and profitability are volatile?

The drivers of relative farm performance have been a longstanding area of interest for agricultural economists. Previous studies have found a range of factors that affect performance differences across farm operations, in both grain and livestock operation contexts. These factors include financial management and cost control, marketing activities such as forward contracts, managerial ability of the farm operator, and economies of scale. Various studies have focused on grain farms in Illinois (Sonka, Hornbaker, & Hudson, 1989), dairy operations in Pennsylvania (Ford & Shonkwiler, 1994) and New York (Gloy & LaDue, 2003; Gloy, Hyde, & LaDue, 2002), and national samples of U.S. farm operations (Lund & Hill, 1979; Mishra & Morehart, 2001). More recently, a series of *farmdoc daily* articles have examined the differences in revenue and production cost levels for Illinois grain farms in high- and low-return performance groups (Paulson, 2011, 2012a, 2012b, 2012c; Schnitkey, Paulson, & Lattz, 2017a and 2017b; Lattz, 2017).

To further explore the factors associated with relative farm performance, we used data from the Illinois Farm Business Farm Management (FBFM) association to identify farms that achieved higher returns, relative to their peers, over both the high/rising return period from 2010 to 2012 and the low/declining return period from 2014 to 2016. While there may be concern over the representativeness of a sample of farm management association members, summary statistics of cooperating members of FBFM are similar to those reported for Midwest commercial grain farms in statistically representative survey data from the USDA (Kuethe et al., 2014). Our analysis of the FBFM financial records shows a significant gap in the returns earned by farms over time and that these differences are persistent. This suggests that there are farm operations that do consistently outperform their peers.

Next, we examined the characteristics of farms that were part of the various performance groups in more detail. Farms earning higher returns usually do so through a combination of both higher revenues and lower costs. Higher revenues are achieved through a combination of higher corn and soybean yields as well as receiving higher prices than farms in the lower return groups. Lower costs are achieved across a range of production cost sub-categories including direct inputs, power and machinery, and overhead.

The relative contribution of higher revenues toward higher returns tends to be more important in comparing high-return farms to those in the mid- or average-return group. In contrast, the relative contribution of lower costs toward achieving higher returns tends to be more important in comparing average- or mid-return farms to those in the low-return group. This article outlines the data and methodology used to make these peer group comparisons, summarizes the results from the comparison, and then discusses the potential implications for farm operators and managers.

## DATA AND METHODS

This study utilized farm business level data from the Illinois Farm Business Farm Management Association (FBFM) from 1995 through 2016. FBFM is a cooperative educational-service program designed to assist farmers with management decision-making. Currently, FBFM comprises more than 5,000 cooperating farmer members served by approximately 100 field staff who provide services including financial statement and tax return preparation, as well as operational benchmarking. The financial records of cooperating farms are certified by the FBFM field staff, resulting in audit quality financial and agronomic information. Research and extension faculty in the Department of Agricultural Economics at the University of Illinois are able to access and use the data for research and extension purposes, while protecting the anonymity and confidentiality of any individual association cooperators.

Because the purpose of this study was to directly compare the financial performance of commercial grain farms in Illinois, subsamples of the farm records were carefully defined to ensure the comparisons were made among appropriate peer groupings. Farm peer groups were defined to be within specific geographic regions of Illinois that have similar soil types, crop rotations, and annual exposure to weather events and overall growing season characteristics over time. A "Central IL" group of farms was selected, covering Champaign, Ford, McLean, and Piatt counties in central/east-central Illinois. A "Northern IL" group of farms was also selected, covering DeKalb, LaSalle, Lee, and Ogle counties in north-central Illinois.

For the Central IL group, the FBFM data include an average of 326 farm businesses per year, ranging from 407 in 1995 to 266 in 2008. For the Northern IL group, the data include an average of 222 farm businesses each year, ranging from 256 in 2003 to 182 in 2015. Within each group, the average size of the farm operations has been steadily increasing over the sample period from an average of approximately 850 acres in 1995 to just over 1,100 acres in 2016.

Within each regional peer group, performance groups were created based on rankings for management and land returns. This return measure is defined as crop revenues less non-land costs. Non-land cost categories include direct inputs (e.g., seed and chemicals), power (e.g., machinery and vehicles), and overhead (labor, buildings, non-land interest, etc.). The return measure selected to define performance does not include land costs, which could be in the form of rental rates or ownership costs (taxes and interest, if applicable).

This management and farmland return was selected in an attempt to isolate the managerial ability associated with non-land, production management decisions. Including land costs might skew the results based on the land tenure position of the operation. For example, if land costs were included, some farms might be classified in the higher-performance groups consistently if their returns are high because of low-cost, owned farmland that has been controlled by the family for multiple generations.

The performance groups were defined based on operator and farmland returns earned in the 2011 crop year. Farm operations in the data set for 2011 were ranked and sorted by the management and land return measure. The high-return group consists of the farm operations with returns in the top one-third in 2011. Similarly, the mid- and low-performance groups consist of farms that earned returns in the middle and bottom one-third, respectively, in 2011.

Each farm performance group was then compared across two three-year periods characterized by very different economic environments. The first is across the 2010 to 2012 crop years, a period of high and volatile commodity prices, increasing costs, and generally high return levels. The second period is across 2014 to 2016, an era characterized by lower commodity prices, relatively flat production costs, and much lower return levels. The high-, mid-, and low-performance groups were then compared with respect to average revenues and costs across each of the categories included in non-land costs over each three-year period.

Importantly, the farms within the return groups were fixed based on the 2011 crop year rankings. Thus, the farms within each performance group do not change over time, and farms that were ranked in the top, mid, or bottom third of performance in 2011 may have ranked in a different performance group in other years. The tendency for farms to remain in the same performance group across time captures the concept of return persistence, or consistent performance.

## RESULTS

After defining the farm performance groups, we first examined whether relative return performance was persistent. Or, do farms that rank in a certain performance group in a single year tend to rank in the same performance group in other years as well? Figure 1 plots average returns within the performance groups for Central IL, with the rankings defined based on 2011 returns, from 2009 through 2016. Evidence of return persistence exists, as the average return within each performance group shows significant separation for multiple years prior to, and following the year in which the rankings were defined. For 2011, average returns were $228/acre greater, on average, for the farms in the high-return group, compared with the low-return group. The difference between the high- and low-return groups averaged nearly $150/acre each year from 2009 to 2016.

To further evaluate return persistence, the correlation among return level ranks for the farms in each group in Central IL was computed. Returns for single years through five-year return averages were ranked, and correlations computed across the full available panel of the FBFM data (1995 to 2016). The rank correlation for all consecutive, single year pairs of return rankings was statistically significant at a value of 0.40. Figure 2 shows that the strength of the correlation of ranks of average returns increases with the length of time over which the average returns are computed. When average returns are based on five consecutive crop years, rank correlations increase to 0.6 and remain statistically significant. These correlation results show a strong positive correlation between farms' return rankings across individual years as well as average returns across longer consecutive timeframes. This provides further evidence of persistence in returns, or that farms tend to consistently outperform (or underperform) their peers when returns are averaged over multi-year timeframes.

Next, we examined how the high-performance farms achieved their consistently higher return levels — through higher revenues, lower production costs, or a combination of both. For both regional groups, Central and Northern IL, the results indicate that the relative ranking of performance groups is driven by a combination of higher revenues and lower costs. However, the relative importance of revenue versus cost depends on which groups are compared, as well as the economic environment in which the farms are operating.

Figure 3 illustrates the return differences between the high- and mid-performance groups in Central IL during the 2010 to 2012 and 2014 to 2016 periods. For 2010 to 2012, higher revenues dominate, accounting for nearly 80 percent of the $115 return gap between groups, while lower power and overhead costs accounted for the remaining 20 percent. Direct input costs were actually the same on average for the mid- and high-performance groups. From 2014 to 2016, the effect of higher revenues was still the dominant factor, accounting for 60 percent of the return gap between high- and mid-performance groups. Lower direct input, power, and overhead costs accounted for the remaining 40 percent.

Turning attention to the comparison of mid- and low-performance groups in Central IL illustrated in figure 4, the importance of cost control becomes more important. From 2010 to 2012, the $80 gap in returns between mid- and low-performance farms was split evenly among revenues and costs. For 2014 to 2016, lower costs dominate with over 75 percent of the gap in returns explained by lower input, power, and overhead costs versus 25 percent attributable to higher revenues.

For the Northern IL farms, illustrated in figures 5 and 6, the results are similar. Comparing the high- and mid-performance groups, higher revenues are the dominant factor accounting for 75 percent of the $118/acre return gap for 2010 to 2012. In contrast, lower costs account for 80 percent of the nearly $100/acre return gap over 2014 to 2016. For the mid- to low-performance group comparison, lower costs actually dominate over both time periods examined. From 2010 to 2012, lower costs accounted for nearly 70 percent of the $85/acre return gap. Lower costs were an even greater factor for 2014 to 2016, accounting for over 80 percent of the $100/acre return gap between mid- and low-performance farms in the Northern IL group.

The results for the Central and Northern IL regions suggest that revenues can explain the majority of the differences in returns earned between the high- and mid-performance groups, particularly during periods of high and volatile commodity prices such, as the 2010 to 2012 period. However, during a period of lower prices and tighter margins, such as 2014 to 2016, the relative importance of cost control seems to increase. This is particularly true for the comparison between mid- and low-performance groups in each region. Thus, for farm operations that find themselves consistently underperforming relative to peer benchmarks, financial management via cost control may be the best area to focus managerial decisions. For farms performing near the average of peer benchmarks, managerial strategies focused on revenue enhancement, such as crop marketing plans and/or productivity increases, may do the most to help the farm move into the high-return category among its peers.

## Revenue Factors

Further examination of the average revenues earned by each performance group showed an average corn yield advantage of approximately 10 bushels per acre for the high-return farms compared with the low-return groups in both regions. The yield advantage for soybeans averaged approximately 3 bushels per acre. These yield differences were slightly larger during 2010 to 2012, probably because of high yield variability experienced during the 2012 drought. Yield differences were slightly smaller over 2014 to 2016 when yields were consistently above average across much of the Corn Belt including Illinois.

The high-return groups received $0.15 to $0.20 per bushel more for corn during the 2010 to 2012 period when prices were relatively high and volatile. The price gap for corn was only $0.05 to $0.10 per bushel on average for the lower price period from 2014 to 2016. Results are similar for soybeans, with an average price difference of $0.40 to $0.50 per bushel from 2010 to 2012, but only $0.10 to $0.15 per bushel from 2014 to 2016.

## Cost Factors

The direct input cost category includes seed, fertilizer, pesticides, and drying and storage costs. Differences in direct input costs across performance categories were mainly driven by differences in seed and fertilizer costs, with the high-performance group spending approximately $10 per acre less than the low-performance group in Central IL, and an average of $15 per acre less in Northern IL. Note that the high-performance farms are spending less, on average, on crop inputs, while simultaneously achieving higher crop yields on similar land in the same region. This suggests that high-performance farms tend to make more efficient input choices and/or procure seed and chemical inputs at lower unit prices.

The power cost category tended to account for the largest share of lower costs, compared with direct inputs and overhead. The high-performance group in Central IL had an average power cost that was $35 per acre lower than the low-performance group. The difference in Northern IL was even greater, with an average power cost difference of nearly $50 per acre between the high- and low-return groups. Power costs include variable components such as fuel, oil, and repairs, but tend to be dominated by depreciation. The depreciation reported in the FBFM data is an estimate of annual economic depreciation. Thus, larger depreciation values indicate a higher valued machinery complement, given the size of the farm. This is strong evidence of the importance of appropriately sizing an operation's machinery complement to achieve the lowest cost per acre possible.

Overhead costs also revealed a significant separation between the high-, mid-, and low-return farm groups in both regions. In Central IL, total overhead costs tended to be $20 to $25 per acre lower on the high-return farms compared with the low-return farms. This gap was wider in Northern IL, where the high and low groups were separated by $25 to $30 in overhead costs. The main contributors within overhead cost categories were labor and interest. With respect to the labor cost gap, high-return farms may undervalue the larger share of unpaid labor provided by the farm operators.

## Other Factors

Some additional farm characteristics that were explored include farm size, soil productivity, and crop rotation choices among the return groups. No clear differences existed in terms of the average soil productivity between the return groups in either region. Again, the regional farm groups were specifically selected to make the comparisons fair and appropriate. High soil productivity is, in general, associated with greater returns (and thus, higher land costs) in Illinois. However, productivity differences across the farms within the Central and Northern county regions was minimal.

Similar to previous studies, larger farms tended to have higher returns. Farms in the high-performance groups were 100 to 200 acres larger than those in the mid-performance group. A similar difference in average farm size was observed when comparing the mid-and low-return groups. While this supports previous work as well as anecdotal evidence of economies of scale for grain operations, the range of farm size in the FBFM data is fairly limited. The average farm size is between 1,000 and 1,100 acres, and the vast majority of cooperating farms are between 500 and 2,500 acres. The data set includes very few small (less than 500 acres) or very large (greater than 5,000 acres) grain farm operations.

Finally, slight differences in crop rotation existed with the high-return farms averaging a rotation relatively close to 50 percent corn, 50 percent beans. The mid- and low-return groups tended to have slightly more intensive corn rotations (55 to 60 percent corn). However, caution is advised when generalizing recommendations from this observation, as it is likely driven by the historically unique experience of average soybean enterprise returns exceeding corn returns over a number of the years considered in this analysis.

## DISCUSSION AND CONCLUSIONS

In this analysis, financial records from the Illinois Farm Business Farm Management (FBFM) association were used to determine whether evidence of return persistence exists. Then, regional farm peer groups were defined and compared to analyze differences in performance.

Evidence of the persistence of farm returns was shown by comparing average returns of the fixed peer groups across multiple crop years. The data show that farms classified in the high-return group based on a single year (2011) achieved higher average returns in years prior to 2011 and continued to have higher average returns than the mid- and low-return groups in crop years following 2011. Further support of return persistence over the full 1995 to 2016 timeframe was provided by correlations of the farms' average return rankings. This was true for consecutive single year returns as well as consecutive timeframes of up to five crop years in length. The strength of the positive correlation between average returns actually becomes greater as the length of time over which returns are averaged increases. Both approaches suggest farm returns are persistent, or that some farms consistently outperform their peers by earning greater returns over multiple crop years.

To further investigate how the high-performance groups achieve higher return levels consistently over time, the revenues and non-land cost categories for each performance group were compared. Two specific three-year periods were examined, each characterized by different economic environments: a high, volatile price period with relatively high returns from 2010 to 2012, and a low price and return period from 2014 to 2016.

General results from both regional peer groups suggest several general findings that could be useful for farm operators and farm managers. First, the gap between high- and low-return farms tends to be dominated by revenue differences, suggesting that the development of marketing skills and adoption of productivity enhancing strategies can help average farms become high performers. Thus, farms currently performing at or near peer benchmarks may be best served by focusing on the development of more sophisticated marketing strategies and adopting technologies that will improve crop yields without significantly increasing production costs.

Second, cost differences tend to be more important when looking at the return gap between mid- and low-performance farms, suggesting that farms currently performing below peer benchmarks may be best served by focusing on financial management and cost reduction strategies. Farms currently underperforming peer benchmark returns might be advised to focus on cost control to improve returns before examining marketing or productivity strategies.

Third, the economic environment affects the relative importance of revenue and cost advantages across performance groups. During 2010 to 2012, revenue differences made up a larger portion of the return gaps between performance groups than during 2014 to 2016. The earlier period was characterized by higher and more volatile commodity prices, and more variable growing conditions (i.e. 2012 drought). Therefore, there was naturally more variation in realized revenue levels on grain farms, and greater opportunities to create performance gaps through successful crop marketing. In contrast, 2014 to 2016 was characterized by lower prices, excellent and stable yields, and lower returns. Thus, variation in revenues was lower, and return variability was driven primarily by production cost differences.

More detailed examination of the cost advantages of high-return farms showed that machinery depreciation within the power cost category, seed and fertilizer costs within the direct input cost category, and labor within the overhead costs category account for the majority of differences. This highlights the importance of choosing the most efficient, return maximizing levels for all inputs, including capital and labor.

While this analysis has illustrated the differences observed between return groups, the specifics of how these high-return farms achieve higher revenues and lower costs is not as clear. A small number of face-to-face follow-up interviews with some of the farm operators from the high-return groups was conducted to try to identify more specific successful management strategies. Some of the consistent messages from the nine producers who were interviewed suggested careful and informed approaches to new technology adoption, diversifying to higher value enterprises such as seed production on a portion of acres, and the importance of negotiating discounts or improved terms on input purchases.

## REFERENCES


Ford, S.A. and J.S. Shonkwiler. 1994. “The Effect of Managerial Ability on Farm Financial Success.” *Agricultural and Resource Economics Review* 23(2): 150–157.

Fox, G., P. A. Bergen, and E. Dickson. (1993). “Why Are Some Farms More Successful than Others? A Review.” In A. Hallam (ed.), *Size, Structure, and the Changing Face of American Agriculture*. P. 232S250. Boulder, Colo.: Westview Press.

Gloy, B.A., and E.L. LaDue. 2003. “Financial Management Practices and Farm Profitability.” *Agricultural Finance Review* 63(2): 157–174.

Gloy, B.A., J. Hyde, and E.L. LaDue. 2002. “Dairy Farm Management and Long-Term Farm Financial Performance.” *Agricultural and Resource Economics Review* 31(2): 233–247.

Kuethe, T.H., B. Briggeman, N.D. Paulson, and A.L. Katchova. 2014. “A Comparison of Data Collected Through Farm Management Associations and the Agricultural Resource Management Survey.” Agricultural Finance Review 74(4): 492–500.

Lattz, D. “IFES 2017: Habits of Financially Resilient Farms – Continued.” Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, January 24, 2018.

Lund, P. J., and P. G. Hill. 1979. “Farm Size, Efficiency, and Economies of Size.” *Journal of Agricultural Economics* 30(2): 145–158.

Mishra, A., and M.J. Morehart. 2001. “Factors Affecting Returns to Labor and Management on U.S. Dairy Farms.” Agricultural Finance Review 61(2): 123–140.

Paulson, N., and X. Lu. “Persistence in Management Returns for Illinois Grain Farms, 2005–2009.” *farmdoc daily* (1):206, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, December 8, 2011.

Paulson, N. “A Follow Up on the Persistence of Management Returns: Yields and Prices.” *farmdoc daily* (2):30, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, February 16, 2012a.

Paulson, N. “An Annual Look at the Components of Management Returns for Illinois Grain Farms.” *farmdoc daily* (2):40, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, February 29, 2012b.

Paulson, N. “Annual Management Return Performance for Illinois Grain Farms: Yields and Prices.” *farmdoc daily* (2):58, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, March 28, 2012c.

Paulson, N. “IFES 2017: Habits of Financially Resilient Farms.” Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, January 10, 2018.

Schnitkey, G., N. Paulson, and D. Lattz. “Differences in Revenue and Costs for Higher and Average Return Grain Farms.” *farmdoc daily* (7):104, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, June 6, 2017.

Schnitkey, G., N. Paulson, and D. Lattz. “How Hard Is It to Be Above Average in Farming?” farmdoc daily (7):98, *Department of Agricultural and Consumer Economics*, University of Illinois at Urbana-Champaign, May 26, 2017.

Sonka, S. T., R. H. Hornbaker, and M. A. Hudson. “Managerial Performance and Income Variability for a Sample of Illinois Cash Grain Producers.” North Central Journal of Agricultural Economics 11.1 (1989): 37–47.


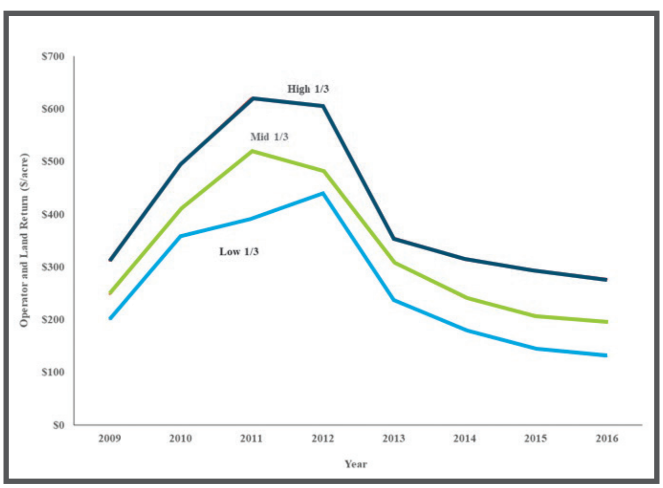


Figure 1. Comparison of Returns for High-, Mid-, and Low-Performance Groups in Central IL, 2009 to 2016

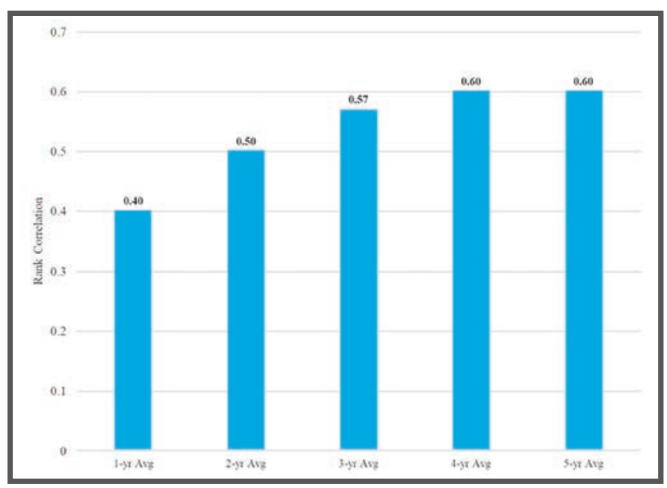


Figure 2. Rank Correlations of 1-year to 5-year Average Returns in Central IL, 1995 to 2016

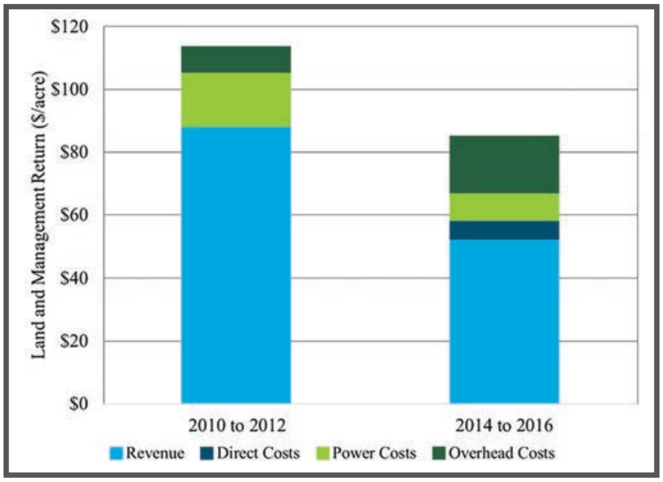


Figure 3. Comparison of High- and Mid- Return Groups, Central IL

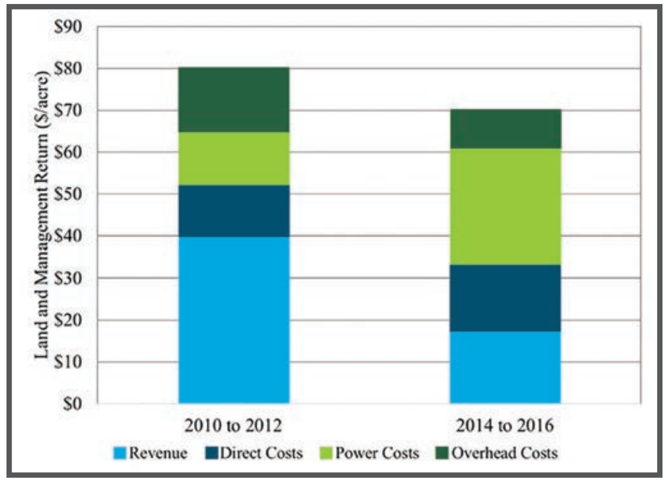


Figure 4. Comparison of Mid- and Low-Return Groups, Central IL

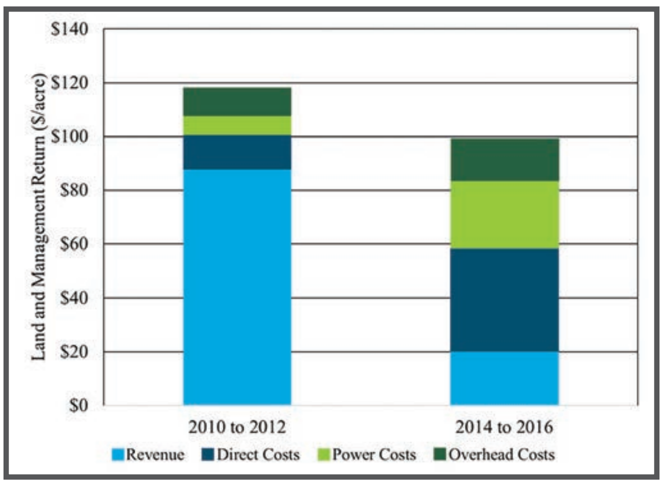


Figure 5. Comparison of High- and Mi- Return Groups, Northern IL

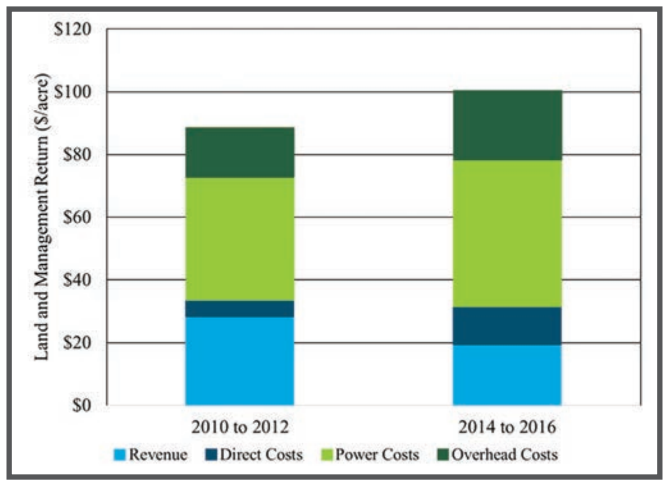


Figure 6. Comparison of Mid- and Low-Return Groups, Northern IL

# A ProfitLink Decision Tree for Farm Financial Managers

**By Brian Briggeman, Mark Dikeman, Elizabeth Yeager, and Robin Reid**

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## Abstract

*The DuPont profitability model provides farm financial managers insights in the financial condition of their farmer and rancher clients. Through the use of the ProfitLink decision tree, managers are able to provide clear feedback and support to clients by quickly identifying which component of the DuPont model is driving the profitability issues and providing a starting point in conversations regarding changes that might be made on the farm or ranch to mitigate the issues.*

## INTRODUCTION TO THE DUPONT MODEL

Net farm income is forecasted to decrease again in 2018 to the lowest real-dollar level since 2002 (USDA ERS 2018). In Kansas, net farm income was up in 2017 compared to the last two years, yet roughly 50 percent of levels three years ago and almost one-third of farms reported negative net farm income (Peter, 2018). This, coupled with anticipated increases in production costs and the steep declines in farm income after 2013, has led to the need for more tools farm financial managers can use when meeting with clients and providing critical analysis.

One such tool is the DuPont profitability model. This model gained popularity among business school experts because of its simplicity (Van Voorhis, 1981). It allows analysts to more quickly and clearly answer the question of "How can my business perform better?" The ability to breakdown the DuPont profitability model (discussed below) allows for recommendations to be made regarding specific components generically broken into the "income stream" and "investment stream" (Van Voorhis, 1981). While gaining popularity among non-farm or ranch businesses, the calculation of profitability and financial efficiency ratios as recommended by the Farm Financial Standards Council (FFSC) made it arguably more difficult for farm businesses. The model and adjustments to account for the FFSC ratios has been previously discussed in this journal as the "ROA Dilemma" (Barnard & Boehlje, 2004). The key ratios from FFSC used in the DuPont profitability model are operating profit margin, asset turnover, return on assets, and return on equity. Examining these measures together illustrates how well the business is performing financially and is important for a critical analysis of financial performance (Melvin et al., 2004). The objective of this study is to revisit the adjusted DuPont profit-ability model and to assist farm financial managers in their discussions with clients through the use of the ProfitLink Decision Tree introduced below.

## AN ADJUSTED DUPONT PROFITABILITY MODEL

The basis of the decision tree comes from the DuPont profitability model. Traditional business textbooks simply show the DuPont equation as being three levers a firm can pull to enhance return on equity or ROE — profit margin, turnover, and the equity multiplier or leverage. However, the business school approach to the DuPont model masks a unique insight that can be shown with a bit of algebra: the effective use of debt. A slightly adjusted DuPont model still puts emphasis on profit margin and turnover, but the effective use of leverage is shown. Gaining additional insights into the effective use of leverage is what makes the ProfitLink Decision Tree novel and serves as the decision tree's foundation.

The DuPont profitability model provides farm financial managers insights in the financial condition of their farmer and rancher clients. The model decomposes the ROE ratio into two key areas. First is operating performance. Analysis of this area focuses on the business' profit margin, efficient use of assets, and the return on assets (ROA). The second area is financial performance, which focuses on the effective use of leverage by examining the business' cost of debt and leverage. When combined, operating performance and financial performance reveal how well a business is generating a return on the owner's invested capital as follows:

$$(1)\quad ROE = \underbrace{Earns * Turns}_{\text{Operating Performance}} + \underbrace{\text{Effective Use of Leverage}}_{\text{Financial Performance}}.$$

Equation 1 is a slightly revised version of the business school DuPont model. Usually, the DuPont model multiplies earns (profit margin) times turns (turnover ratio) times leverage (equity multiplier). However, putting emphasis on the effective use of leverage allows the financial manager to have a deeper discussion about debt usage and debt costs. Operating performance is similar but there is a key difference when calculating the ROA ratio, the primary ratio to assess operating performance. The key revision is that operating performance is calculated on a before-interest expense basis. The reason for this is because showing whether or not the business is using debt effectively depends on whether or not the business utilizes its assets to generate a large enough return to cover the debt costs of those assets. The first step is to calculate a before-interest ROA ratio is as follows:

$$(2)\quad ROA = \frac{(\text{Net Income+Interest Expense})}{\text{Gross Revenue}} * \frac{\text{Gross Revenue}}{\text{Total Assets}}$$

Calculating a before-interest ROA ratio removes any aspect of financing when assessing the operating performance of a business. The focus is solely on how well assets are used to generate a return for the business, regardless of how the assets are capitalized. Of course, a portion of these returns is used to cover the costs of debt, which is the next step in calculating this adjusted DuPont model.

The final component to calculate is the effective use of leverage. For many farmers, using debt effectively to enhance ROE can be a struggle. To clearly show how debt can help a business, the effective use of leverage includes a *Spread Above Interest Costs* variable:

The *Spread* variable serves two purposes. First, *Spread* is key to the algebraic derivation of ROE in equation 1. Given ROA is calculated on a before-interest basis, interest expense must be subtracted from ROA to calculate ROE. Furthermore, interest expense is divided by total liabilities to account for total liabilities and to account for total assets. So the *Effective Use of Leverage* variable, because of *Spread*, reduces equation 1 to the standard ROE calculation of net income divided by total equity.

The second purpose of the *Spread* variable is to identify whether or not the farm or ranch is using debt effectively. In order for the *Spread* variable to be positive, the farm or ranch must be generating a large enough ROA before interest to cover the average interest cost of liabilities. (*Interest Expense / Total Liabilities*). When that is the case, the farm is effectively using debt and will have the farm's ROE increase with leverage. This is the case because, *ROE = ROA + (Spread Above Interest Costs * Leverage).*

But if Spread is negative, then the farm is not using debt effectively. The farm is not generating a sufficient return on assets to cover interest costs. The farm or ranch's interest costs are too large relative to the return generated from assets. As a result, a higher leverage ratio will actually lower the farm's ROE and signals the farm is not using leverage effectively.

Identifying ways to boost operating performance is key to addressing a negative Spread. The ultimate measure of operating performance in the adjusted DuPont model is ROA. If ROA increases, that will bolster operating performance, and will also lift ROE through enhanced financial performance. Moving ROA high enough so Spread turns positive is key to a farm effectively using debt.

A closer examination of the relationship between ROE and ROA gives an indication whether or not the farm has a debt problem. If ROE is greater than ROA, that means the Spread variable is positive and the farm is utilizing debt in the operation to its benefit. However, if ROE is less than ROA, there is a debt issue because the *Spread* variable will be negative. Therefore, any profitability analysis of a farm or ranch should first examine the relationship of ROE to ROA.

Lastly, it should also be noted that standard farm financial statements do require some additional adjustments. Following Farm Financial Standards guidelines, Net Farm Income (or Net Income in the adjusted DuPont profitability model) does not include family living. Standard DuPont profitability models account for salaries paid to the owner, i.e., family living, through selling, general and administrative expenses. So, the *Net Income* number presented in equation 2 should account for family living. Also, any accrual adjustments to a cash-based income statement, such as inventory adjustments, must be accounted for in the calculations. In the Appendix, a hypothetical farmer-based income statement and balance sheet are presented to demonstrate how this information should be entered into the adjusted DuPont profitability model.

## ANALYZING PROFITABILITY: THE PROFITLINK DECISION TREE

The ProfitLink Decision Tree provides farm financial managers a systematic way to analyze and identify potential financial issues or when it might be appropriate for the farm to expand. To identify issues the ProfitLink Decision Tree — hereafter decision tree — follows the adjusted DuPont profitability model. After going through a series of ratios compared to benchmarks, a likely area of financial stress is identified. Once the issue is identified, the discussion can move to ways to alleviate the stress and enhance operating performance.

Operating performance is key to improving a farm's financial position. The DuPont model discussed earlier shows that financial performance is influenced by a business' profit margin and turnover ratios. So the strategies presented in the decision tree's boxes (Figure 1A), focus on methods to boost revenues, reduce costs, manage assets more efficiently, etc.

The start of the decision tree compares ROE to ROA. If ROE is greater than ROA, the financial manager knows that debt is being used effectively. Then the question is whether or not the ROE exceeds an acceptable rate of return. In the decision tree, a place holder of 8 percent is used because, according to Kansas Farm Management Association data, the 10-year average ROE for the top 25 percent of farmers is approximately 8 percent. If the farm and/or ranch is still experiencing financial difficulty even with an ROE above 8 percent, the problem is probably not tied to profitability. The financial manager should further examine issues related to cash flow, liquidity, and/or solvency.

If ROE is less than ROA, the farm probably has a financial performance issue. The lack of performance could be minor. For example, if the ROA is greater than 7 percent, then operating performance is close to the financial performance benchmark, which is 8 percent. In this scenario, the farm is probably not using debt effectively. A negative spread above interest costs is probably dragging down the ROE. To fix this situation, debt could be restructured or paid down.

If the ROE and ROA are not meeting their respective benchmarks, then there is clearly an operating performance issue with the farm. So, from this point forward on the decision tree, the focus is on the asset turnover ratio (ATR) and the operating profit margin ratio (OPM). The benchmarks set for ATR and OPM are 0.35 and 0.20, respectively. The reason for these benchmarks is twofold. First, the 10-year average ATR and OPM for the top 25 percent of farmers in the Kansas Farm Management Association data are near 0.35 and 0.20, respectively. Multiplying the two together yields an ROA equal to 0.07 or 7 percent or the ROA benchmark. Second, these benchmarks are close to the benchmarks recommended in various sources (Kohl & Wilson, 1997; CFFM, 2018; Plastina, 2017).

Knowing this and following the decision tree, if the ROA is less than 7 percent, ATR is greater than 0.35, and OPM is greater than 0.20, then there is probably a computational issue when calculating the adjusted DuPont profitability model. The financial manager should go back and double check their calculations.

If ATR exceeds its benchmark but OPM does not, then there is probably a cost issue dragging down operating performance. In this scenario, the assets are being used to generate adequate revenues. So, if the revenues are not high enough to offset their associated expenses, then profitability has to be the issue. Here, the farm financial manager should evaluate and identify production inefficiencies, closely examine variable costs, and pay attention to family living expenses. It is important to do a deeper dive into enterprise analyses to truly identify the underperforming areas of the farm.

If ATR is not meeting its benchmark but OPM does, then there is likely a scale issue. Assets are not being utilized in a way to generate enough revenues. Possibly there are assets that need to be culled or used in a manner to drive up revenues. It is also likely that fixed costs for the operation are too high. To improve financial performance in this area, a deeper dive into the asset utilization for each enterprise is paramount.

Lastly, if ATR and OPM are not meeting their benchmarks, there is a significant operating performance issue. Potentially this is a short-term issue that can be fixed quickly. Restructuring debt, examining asset mix, lowering family living, and/or finding new revenue sources are all possible ways to rectify this issue. However, if this is a long-term problem, then the farm financial manager should have a difficult conversation with the producer. The conversation should center on the family's well-being and whether or not the producer should exit farming all together.

To further assist in how to apply this approach to assessing a farm's financial position, an example set of financial statements, calculations, and completed ProfitLink Decision Tree is provided in Appendix 1. Note that this set of materials in the Appendix is of a hypothetical farm and only provided for education purposes.

## A FINAL COMMENT

During difficult financial times, it is vital for farm financial managers to have a focused and constructive discussion about improving a farm's operating and financial performance. A straightforward approach to leading this discussion is available through the previously discussed ProfitLink Decision Tree. The adjusted DuPont profitability model provides the necessary ratios to help a farmer understand their best course of action to either grow or improve their operation. With the ProfitLink Decision Tree rooted in a model focused on profitability, a farm financial manager has a tool to help farmers and ranchers move past difficult economic times.

## REFERENCES


Barnard, F. L., and M. Boehlje. 2004. "Using Farm Financial Standards Council Recommendations in the Profitability Linkage Model: The ROA Dilemma." *Journal of Farm Managers and Rural Appraisers*. https://higherlogicdownload.s3.amazonaws.com/ASFMRA/aeb240ec-5d8f-447f-80ff-3c90f13db621/UploadedImages/Journal/213.pdf.

Center for Farm Financial Management (CFFM). 2018. "Farm Finance Scorecard." University of Minnesota. https://www.cffm.umn.edu/Publications/pubs/FarmMgtTopics/FarmFinance-Scorecard.pdf.

Kohl, David, and Troy Wilson. 1997. "Understanding Key Financial Ratios and Benchmarks." Northwest Farm Credit Services, Business Tools Bulletin. https://www.northwestfcs.com/-/media/Files/Publications/BMC/BT-Understanding-Key-Ratios.ashx?la=en.

Melvin, Jon, Michael Boehlje, Craig Dobbins, and Allan Gray. 2004. "The DuPont profitability analysis model: An application and evaluation of an e-learning tool." *Agricultural Finance Review* 64(1): 75–89. DOI:10.1108/00214660480001155.

Peter, Mary Lou. 2018. "Kansas net farm income climbs, but still far below three years ago; Kansas Farm Management Association releases 2017 data." K-State Research and Extension News. http://www.ksre.k-state.edu/news/stories/2018/06/kansas-net-farm-income.html.

Plastina, Alejandro. 2017. "Financial Performance Measures for Iowa Farms." Ag Decision Maker. https://www.extension.iastate.edu/agdm/wholefarm/pdf/c3-55.pdf.

USDA ERS. 2018. "Highlights from the February 2018 Farm Income Forecast; Farm Sector Profits Expected to Decline in 2018." https://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/highlights-from-the-farm-income-forecast/.

Van Voorhis, Kenneth R. 1981. "The DuPont Model Revisited: A Simplified Application to Small Business." *Journal of Small Business Management* 19:45–51.

# APPENDIX

The purpose of this appendix is to demonstrate how an income statement and balance sheet can be used to calculate the equations in the ProfitLink Decision Tree. The equations come from the adjusted DuPont profitability model. Once the numbers are calculated, the ProfitLink Decision Tree can be used to identify a potential financial problem faced by the producer.

Below is a hypothetical income statement and year-end balance sheet.

| INCOME STATEMENT | |
|---|---|
| Livestock Income | $0 |
| Crop Income | $352,455 |
| Other Income | $44,000 |
| Inventory Adjustment | ($29,420) |
| **Gross Revenue** | **$367,035** |
| | |
| Operating Expenses | $180,300 |
| Interest Expense | $50,000 |
| Depreciation | $49,000 |
| **Total Farm Expenses** | **$279,300** |
| | |
| **Net Farm Income** | **$87,735** |
| | |
| **Family Living** | **$60,000** |

| BALANCE SHEET | |
|---|---|
| Current Assets | $206,067 |
| Non-Current Accts Rcv | $25,500 |
| Breeding Livestock | $0 |
| Machinery & Equipment | $747,000 |
| Buildings | $72,500 |
| Owned Land | $1,000,000 |
| **Total Assets** | **$2,051,067** |
| | |
| Current Liabilities | $200,750 |
| Non-Current Liabilities | $425,000 |
| **Total Liabilities** | **$625,750** |
| | |
| **Net Worth** | **$1,425,317** |

Note that the income statement does make an accrual adjustment for inventories. Many financial statements are prepared using cash accounting methods. It is recommended that adjustments be made to convert cash-based income statements to accrual to provide a more accurate indication of the business' financial position. Either gross revenue or value of farm production can be used in the calculation. In this example, there is no livestock income, so gross revenue and value of farm production are equivalent. When livestock is a part of the business, value of farm production needs to be used. Value of farm production takes into account the cost of purchased feeder livestock and purchased feed for that livestock. In other words, these purchases represent cost of goods sold and should be subtracted from the gross revenue measure. Also note that the operator's income or family living needs to be accounted for in the analysis. Therefore, it is an additional expense included in the *Operating Profit Margin* calculation. The adjusted DuPont profitability model can be calculated as follows:

(1A) *Operating Profit Margin or Earns =* $\frac{(\$87,735+\$50,000-\$60,000)}{\$367,035} = 0.212$

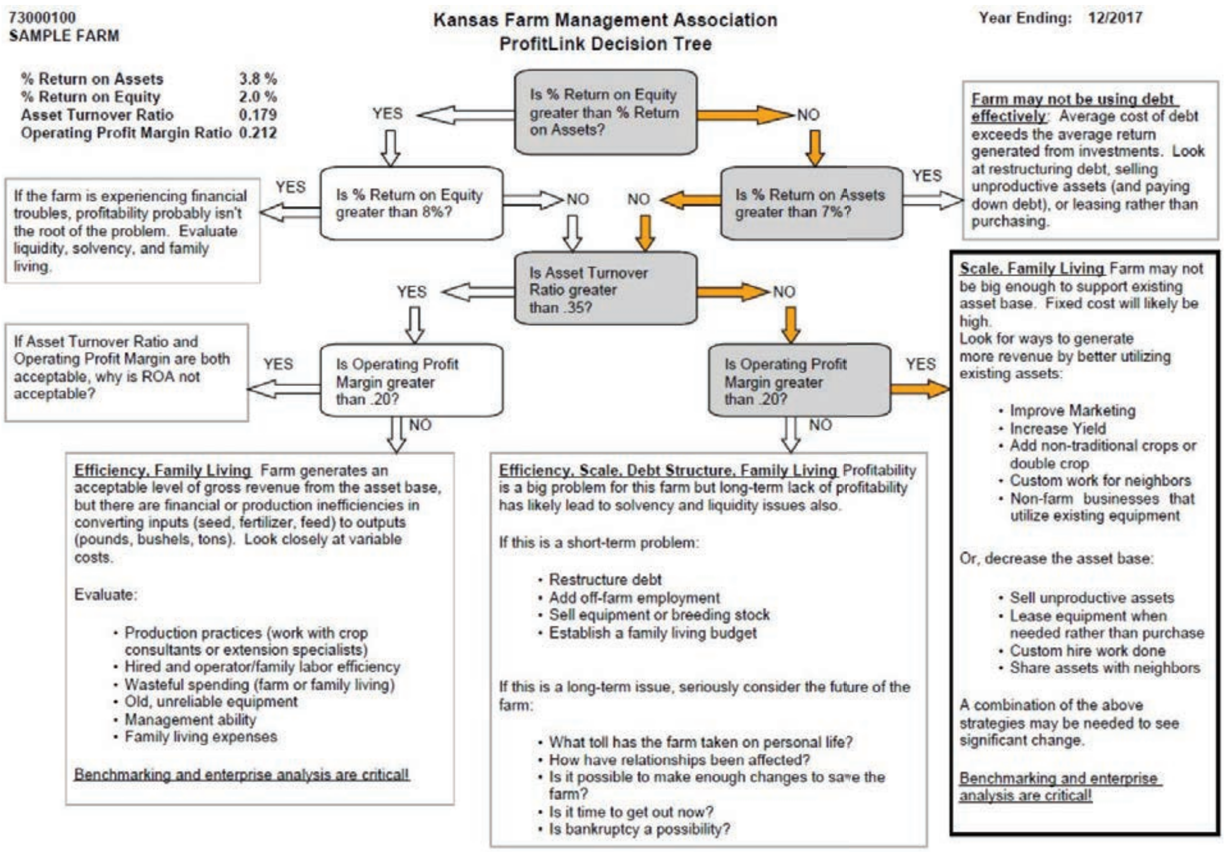
(2A) *Turns =* $\frac{\$367,035}{\$2,051,067} = 0.179$

(3A) *ROA* = 0.212 * 0.179 = 0.038 *or* 3.8%

(4A) *Effective Use of Leverage =* $\left(0.038 - \frac{\$50,000}{\$625,750}\right) * \frac{\$625,750}{\$1,425,317=} = -0.018$

(5A) *ROE =* 0.038-0.018 = 0.02 or 2.0%

These calculations are then used in the ProfitLink Decision Tree. Figure 1A shows the above calculations in the decision tree. In this hypothetical case, the farm financial manager is provided a starting point in the discussion to help their farmer client out of a difficult financial situation. Of course, the boxes containing the possible financial issues are not "perfect" fixes for a financially stressed farmer. Rather, they are there to help facilitate a discussion.




Note: Return on assets is calculated before deducting interest expense.
Figure 1A. Hypothetical ProfitLink Decision Tree Analysis

# Regional and Seasonal Differences in Feeder Cattle Basis


**By Fred Seamon, Jim Sullivan, and Joselyne Umubyeyi**

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## Abstract


*The top three cattle-producing states in the United States are Texas, Nebraska, and Kansas. This study analyzes basis differences across these three key states and analyzes basis seasonality over a five-year period from 2013 to 2017. Results show that there are statistically significant differences in the basis across Nebraska, Kansas, and Texas, with each having, respectively, a stronger, an average, and a weaker basis. No seasonal basis pattern is observed in Nebraska; however, both Texas and Kansas exhibit statistically significant basis patterns, which can affect market participant's hedge expectations in those regions.*


## INTRODUCTION

The U.S. cattle industry is a large and important economic entity. Cattle accounted for 21 percent of the total market for agricultural commodities in the U.S in 2015, with a value of $78.2 billion in cash receipts (National Agricultural Statistics Service et al, 2016). As detailed in a Chicago Mercantile Exchange product bulletin (CME, 2017), a key component of the cattle industry is feeding, which is the process of converting a 600- to 800-pound animal to a finished animal ready for slaughter. Cattle feeding is concentrated in the Great Plains but is also important in parts of the Corn Belt, Southwest, and Pacific Northwest. Cattle feedlots produce high-quality beef that grades USDA Select or higher by feeding grain and other concentrates.

All market participants, including ranchers, stockers, and feeders, face the risk that cattle prices may move adversely. At the feedlot point in cattle marketing, these market participants may use feeder cattle futures to manage price risk. However, these market participants must then bear basis risk. For this study, the feeder cattle basis is defined as the cash price minus the futures price. Understanding the basis is important to firms that use feeder cattle futures to forward price feeder cattle, because changes in the basis change their profits. Firms that currently or potentially trade feeder cattle in various locations are affected by the basis in those different locations. Locational differences in the basis affect decisions regarding the place to buy or sell. Firms that trade feeder cattle at different times during the calendar year are affected by seasonal differences in the basis. Seasonal differences in the basis affect decisions regarding the best time to buy or sell.

The feeder cattle futures contract broadly represents the price of U.S. cattle purchased by feedlots that will likely grade USDA Select or higher and whose intended use of the animals is to feed them for an extended time and then market them for slaughter. The sample of transactions used by CME to calculate the Index — which underlies the futures contract — forces convergence to the weighted average price paid for those cattle across the following states: Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming.

Texas, Nebraska, and Kansas contribute a total of 65 percent of the feeder cattle market in the U.S., each with over 4 million head (Cook *et al*, 2018). Market participants often refer to these states' prices when hedging locally. While efforts in understanding seasonal differences in cattle basis have been conducted in states such as Nebraska (Brooks *et al*, 2016; and Birch *et al*, 2016), Georgia (Curt *et al*, 2014), and Tennessee (McLemore *et al*, 1990), less work has been conducted around both regional and seasonal basis differences across these key states. Additionally, there has been a swift and substantial increase in the quality of U.S. cattle produced in recent years. The U.S. national average percentage of beef graded as USDA Choice remained static between 50 and 55 percent from 1996 until 2009, when it increased for the first time beyond 60 percent. Figure 1 shows the historical increase in the national Choice grading percentage. Considering this significant increase in quality, and the effects that quality could have on basis relationships, a five-year study period from 2013 through 2017 was selected to more closely represent the quality levels currently being produced.

The purpose of this study is to determine whether the feeder cattle basis differs across these key states and within the calendar year. The feeder cattle basis in Texas, Nebraska, and Kansas is graphed to determine whether regional or seasonal differences are apparent visually. Then, statistical analysis is used to determine whether the visual differences are statistically significant. Finally, based on the results of the statistical differences, various hedge scenarios are considered across place and through time.

## CALCULATING BASIS

The cash market for feeder cattle reflects today's supply and demand conditions. Conversely, the futures market is an anticipatory market reflecting expectations of future supply and demand conditions (Lawrence, 2006). Basis relates the local cash market to the futures market for any given commodity and can be obtained by subtracting the future prices from the cash prices. A strong basis refers to a basis value that is more positive or less negative, and a weak basis refers to a basis value that is less positive or more negative.

Daily cash price data for Kansas, Nebraska, and Texas are sourced from the U.S. Department of Agriculture's Agricultural Marketing Services (USDA-AMS). The feeder cattle futures contract, with expirations in January, March, April, May, August, September, October, and November, is a cash settled futures contract based on the CME Feeder Cattle Index. The CME Feeder Cattle Index is based on a sample of transactions of 700- to 899-pound Medium and Large Frame #1 feeder steers and Medium and Large Frame #1–2 feeder steers. The sample consists of all feeder cattle auction, direct trade, video sale, and Internet sale transactions within the 12-state region of Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming for which the number of head, weighted average price, and weighted average weight are reported by the USDA-AMS.[1]

Basis data are created by subtracting the nearby non-spot feeder cattle futures contract price from each cash price observation (i.e., basis = cash price – futures price). The daily observations are then averaged into monthly observations. The data cover a five-year period from 2013 to 2017.

## REGIONAL FEEDER CATTLE BASIS

The Kansas, Nebraska, and Texas feeder cattle bases are graphed in Figure 2. The feeder cattle basis in Nebraska is the strongest; the Texas basis weakest; and the Kansas basis in between. To test whether these visual differences in the feeder cattle basis are statistically significant, the non-parametric Friedman test is used. The Friedman test is appropriate compared to a parametric ANOVA test because the basis observations are not independent; the same futures price is used to calculate the basis across the three states and the cash prices are determined simultaneously.

The Friedman test determines whether the basis observations differ by treatment (three different states) after the effect of the blocking variable (each month of the calendar year) is removed. Given monthly average basis is calculated over five years, the analysis has 60 blocks. The data are organized as follow:

| Date | Nebraska | Kansas | Texas |
|---|---|---|---|
| 1/1/2013 | $B_{1,N}$ | $B_{1,K}$ | $B_{1,T}$ |
| 2/1/2013 | $B_{1,N}$ | $B_{1,K}$ | $B_{1,T}$ |
| . | . | . | . |
| . | . | . | . |
| . | . | . | . |
| 12/1/2017 | $B_{60,N}$ | $B_{60,K}$ | $B_{60,T}$ |

where $B_{i,j}$ represents the observed average monthly feeder cattle basis for observation i (i = 1, 2, ..., 60), in state j (j = N, K, T). The observations in each row from the above matrix are ranked from lowest to highest.

The Friedman test is used to determine whether there are significant differences in the sums of the ranks for each state. Specifically, the test statistic indicates whether the basis in at least one state (column) is significantly different from any other state over the sample period.

The rank sums over the study period are Texas: 180; Nebraska: 113; and Kansas: 67. The calculated Friedman test statistic is 170.26. The null hypothesis is rejected at the 5 percent significance level implying that the feeder cattle basis is different in at least one among the states of Kansas, Nebraska, and Texas.

Multiple comparison analysis applicable to ranked data is available to determine the state or states in which the basis differs. The difference in the rank sums is calculated for each possible pair of states. A test statistic, $q$, is calculated to test the null hypothesis that the monthly state basis is the same for each possible pair of states. The calculated $q$ test statistic is compared to the studentized range critical value, q, which is dependent upon $\alpha$ (the significance level), $\infty$ (infinite degrees of freedom), and $k$ (the total number of states (3) being tested). The third column of Table 1 presents the results of the multiple pairwise comparisons made between each state at the 5 percent significance level. The pairwise comparison results indicate that the differences in the basis between the three states are statistically significant with the Nebraska basis being statistically stronger than the basis in both Texas and Kansas; the Kansas basis being statistically stronger than the basis in Texas; and the Texas basis being statistically weaker than the basis in both Nebraska and Kansas. Many factors can be attributed to these differences in regional basis values. Cattle feeders in the northern regions of the U.S. have access to cheaper corn for feeding compared to those in Texas. There are also notable differences in the quality of the cattle typically found in Nebraska compared to Texas. For example, the five-year average (2013–2017) percentage of cattle grading USDA Choice in Nebraska was 70 percent versus 59 percent in Texas. Lastly, weather conditions are very different when comparing Texas to Nebraska, as very hot and dry summers in Texas can affect an animal's ability to put on weight.

## SEASONAL FEEDER CATTLE BASIS

This section tests for statistically significant seasonal differences in the feeder cattle basis. Figure 3 suggests visually the possibility of a statistically significant basis pattern for both Kansas and Texas. Again, the Friedman test is used to test whether these visual patterns are statistically significant. Each state is tested separately to determine if the basis differs in at least one month of the calendar year. In these tests, the 12 months of the calendar year are the treatments and the five calendar years are the blocks. The data are organized for each state as follows:

| Year | Jan | Feb | Mar | • | • | • | Dec |
|---|---|---|---|---|---|---|---|
| **2013** | $B_{1,1}$ | $B_{1,2}$ | $B_{1,3}$ | • | • | • | $B_{1,12}$ |
| **2014** | $B_{2,1}$ | $B_{2,2}$ | $B_{2,3}$ | • | • | • | $B_{2,12}$ |
| **2015** | $B_{3,1}$ | $B_{3,2}$ | $B_{3,3}$ | • | • | • | $B_{3,12}$ |
| **2016** | $B_{4,1}$ | $B_{4,2}$ | $B_{4,3}$ | • | • | • | $B_{4,12}$ |
| **2017** | $B_{5,1}$ | $B_{5,2}$ | $B_{5,3}$ | • | • | • | $B_{5,12}$ |

where $B_{ij}$ represents the observed monthly average basis for calendar year $i$ ($i$ = 1, 2, . . ., 5), in month $j$ ($j$ = 1, 2, ...,12). The objective is to determine if the basis in at least one month (column) differs from the basis in the other months.

Friedman test results are significant for both Kansas and Texas, which suggests seasonally significant basis patterns in those states; the Friedman test result is not significant for Nebraska, suggesting no significant seasonal pattern and a result that is consistent with Birch et al's results for Nebraska. This suggests that the rate of change in the local Nebraska cash price is not significantly different to the rate of change in the futures price.

Multiple pairwise comparison results are included in Table 2. In Kansas, the December basis is significantly stronger (i.e., the cash price higher relative to nearby futures) compared to all other months, while the basis in March, April, and May is significantly weaker (i.e., the cash price lower relative to nearby futures) compared to all other months. In Texas, the basis in February, December, and January is significantly stronger than all other months, while the basis in October and November is significantly weaker compared to all other months. Many of the factors that contribute to differences in regional basis also contribute to seasonal differences in the basis. Extreme heat in the south in the summer and the potential for cold and wet in the north in the winter are examples of seasonal factors that can contribute to seasonal basis differences. Placements tend to follow a seasonal pattern as well. For example, over the past five years, Texas placements have tended to peak in the late spring as seen in Figure 4. The lack of a significant seasonal pattern in the Nebraska basis is interesting, which likely is an indication of the high quality of cattle produced in the north. While the price of cattle in Nebraska indeed does vary by season, the basis does not vary significantly; it stays strong throughout the year because the cattle are consistently higher quality than the U.S. average.

Hedgers should keep these historical basis relationships in mind when placing hedges and forming marketing expectations.

## CONCLUSION WITH HEDGING EXAMPLES

Feeder cattle are continually produced, but regional and seasonal differences in the basis indicate that hedge results vary based on the location where the hedge is placed and on the time of year. Seasonality of production can only be adjusted up to a point because of the biological nature of cattle. Factors such as weather can play a significant role in the decisions producers make, ultimately affecting price behavior in the market. It also affects a producer's ability to modify production to take advantage of seasonal marketing opportunities. However, to the extent that producers can adjust production, the following hedging results may be expected:

### Kansas

The results indicate that the Kansas feeder cattle basis is significantly stronger compared to Texas as shown in Figure 3 and that there is a significant seasonal pattern, with basis stronger than average in December but weaker than average in March, April, and May, as seen in Table 3. Thus, a feeder cattle producer in Kansas who hedges using feeder cattle futures can expect to lock in better prices relative to feeder cattle producers in Texas, ceteris paribus. Because there is a significant seasonal pattern to the Kansas basis, a feeder cattle producer in Kansas marketing cattle in December can reasonably expect better than average hedge results; and while marketing cattle in March, April, and May, can reasonably expect worse than average hedge results.2

### Nebraska

The results indicate that the Nebraska feeder cattle basis is significantly stronger compared to Kansas and Texas, as seen in Figure 3, and that there is no significant seasonal pattern, as shown in Table 3. Thus, a feeder cattle producer in Nebraska who hedges using feeder cattle futures can expect to lock in better prices relative to feeder cattle producers in Kansas and Texas, ceteris paribus. Because there is no significant pattern to the Nebraska basis, a feeder cattle producer in Nebraska should be able to expect similar hedge results throughout the calendar year.

### Texas

The results indicate that the Texas feeder cattle basis is significantly weaker compared to Kansas and Nebraska, as seen in Table 2, and that there is a significant seasonal pattern, with basis stronger than average in December, January, and February but weaker than average in October and November, as seen in Table 3. Thus, a feeder cattle producer in Texas who hedges using feeder cattle futures can expect to lock in lower prices relative to feeder cattle producers in Kansas and Nebraska, ceteris paribus. Because there is a significant seasonal pattern to the Texas basis, a feeder cattle producer in Texas marketing cattle in December, January, or February can reasonably expect better than average hedge results; and while marketing cattle in October and November can reasonably expect worse than average hedge results.

## ENDNOTE

1. Additional details about the cash-settlement process for lean hogs and feeder cattle futures can be found in the CME Rulebook located at cmegroup.com/rulebook/CME/.
2. A worse than average hedge result does not indicate that a hedge is ineffective in this case; only that cash prices are weaker relative to futures prices, so a seller would, on average, lock-in a lower price relative to futures during this time.
3. Treatments with different letters are significantly different.
4. **Texas** results are grouped from *A*– Significantly Strongest Basis, *B*– Strong Basis, *C*– Average Basis, *D*– Weak Basis, and E– Statistically Weakest Basis. **Kansas** results are grouped from *A*– Significantly Strongest Basis, *B*–Average Basis, and *C*– Significantly Weakest Basis. **Nebraska** results showed no significant statistical differences.

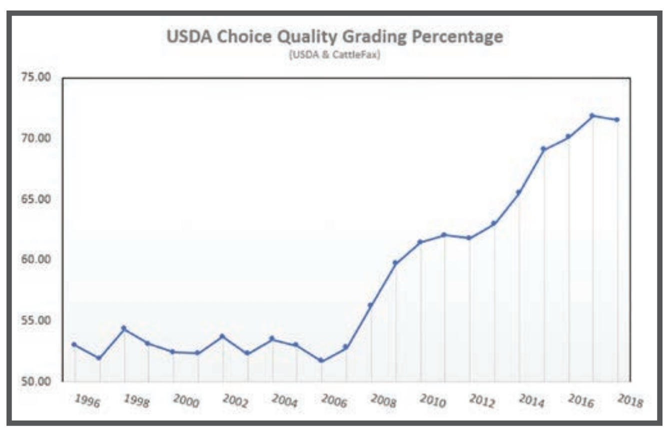


Figure 1. Yearly Average National USDA Choice Grade Percentage (1996–2018)

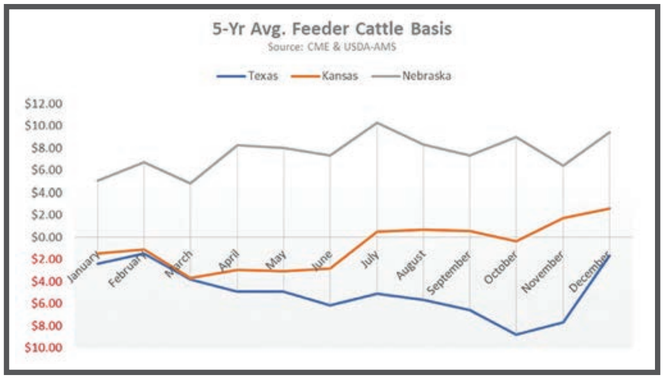


Figure 2. Historical Basis in Texas, Kansas, and Nebraska (2013–17)

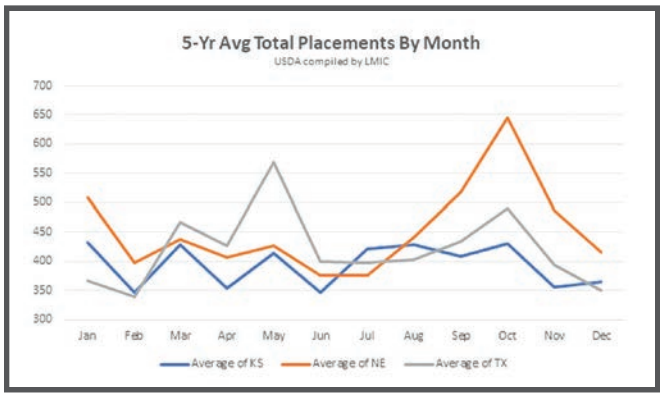


Figure 4. 5-Year Average Placement of Feeder Cattle (2013–17)

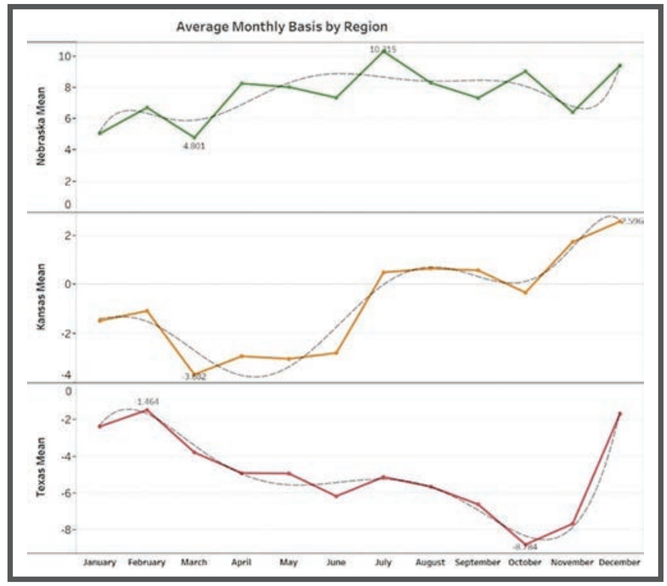


Figure 3. Monthly Average Basis with Smoothing Spline (dotted) by Region

Table 1. Regional Pairwise Comparison Results2, 3

| Region | Average Basis | Sum of Ranks | Pairwise q Group |
|---|---|---|---|
| Texas | 7.5884 | 180 | A |
| Nebraska | -0.7687 | 113 | B |
| Kansas | -4.9487 | 67 | C |

Table 2. Seasonal Pairwise comparison results.3, 4

| Texas | | | Kansas | | | Nebraska | | |
|---|---|---|---|---|---|---|---|---|
| Month | Average Basis | Group | Month | Average Basis | Group | Month | Average Basis | Group |
| February | -1.46438 | A | December | 2.59600 | A | January | 5.06537 | A |
| December | -1.67200 | A | January | -1.48000 | B | February | 6.72011 | A |
| January | -2.36094 | B | February | -1.07400 | B | March | 4.80117 | A |
| March | -3.76859 | C | July | 0.50200 | B | April | 8.26286 | A |
| April | -4.89324 | C | August | 0.66600 | B | May | 8.03399 | A |
| May | -4.91887 | C | June | -2.80000 | B | June | 7.35700 | A |
| July | -5.10778 | C | September | 0.59100 | B | July | 10.31468 | A |
| August | -5.63595 | C | October | -0.32400 | B | August | 8.30003 | A |
| June | -6.15577 | C | November | 1.75500 | B | September | 7.33738 | A |
| September | -6.59602 | C | March | -3.68200 | C | October | 9.03048 | A |
| November | -7.65234 | D | April | -2.93400 | C | November | 6.42638 | A |
| October | -8.78390 | E | May | -3.04100 | C | December | 9.41158 | A |

# Relationship between Cash Rent and Net Return to Land in Indiana

**By Nathaniel Carson and Michael Langemeier**

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## Abstract

*This paper examined the relationship between cash rent and net return to land in Indiana. Short-term and long-term adjustment coefficients for low, medium, and high productivity land in Indiana were used to explore the impact of a $100 per acre change in net return to land on cash rents in subsequent years. There was a significant and positive relationship between cash rent and net return to land for medium and high productivity land. The relatively low coefficients on lagged net return to land in the cash rent equations reinforce the existing literature that asserts that cash rent values are "sticky." For high productivity land, a $100 per acre drop in net return to land would result in a $7.40 per acre drop in cash rent in the subsequent year and a long-term drop of $32.30 per acre in cash rent.*

## INTRODUCTION

Over the past five years, corn and soybean producers in the United States witnessed a dramatic decline in commodity prices. In 2012, the price of corn per bushel was $7.34 and the price of soybeans per bushel was $14.67 (USDA-NASS, *Agricultural Prices*). In 2017, the price for corn was $3.36 per bushel, while the price for soybeans was $9.39 per bushel (USDA-NASS, *Agricultural Prices*). This denotes a price decline of 54 percent for corn and 36 percent for soybeans. Low commodity prices will likely be the extended norm for the next several years (FAPRI, 2018).

Within the state of Indiana, the impacts of low commodity prices are particularly striking. Corn and soybean revenue peaked in 2013 at $4.61 billion and $3.53 billion, respectively (USDA-NASS, *Quick Stats*). From these peaks, corn revenue was 30.1 percent lower and soybean revenue was 13.4 percent lower in 2017. The declining crop production values have Indiana corn and soybean producers looking for ways to decrease their costs and improve their profitability.

Cash rent is a major production cost for producing corn and soybeans in Indiana. From 1990 to 2017, cash rent accounted for, on average, 30 percent of all corn production costs and 39 percent of all soybean production costs. As the profitability of corn and soybean producers continues to stagnate, it is unknown how cash rent values will change across Indiana. Because of the significance of cash rent as a major cost for corn and soybean producers, it is vital that an effective metric exist for evaluating the potential impact of decreased net returns upon cash rent within the state of Indiana.

Research that examines the relationship between cash rent and net return to land is quite limited. Featherstone and Baker (1988) examined the relationship between cash rent and net return to land, and between land values and cash rent for Tippecanoe county in Indiana. Net return to land and cash rent were significantly related to cash rent and land value, respectively. The coefficient on lagged net return to land in the cash rent equation was 0.08. Featherstone et al. (2017) found a significant relationship between land value and net farm income. The authors found that land values adjusted slowly to changes in net farm income.

The objective of this paper is to examine the relationship between cash rent and net return to land in Indiana. At present, research analyzing the relationship between cash rent and net return to land within Indiana by land productivity category is not readily available. Quantifying this relationship across the entire state and by land productivity category would help farm operators in planning financial investments and other farm-related activities.

## MODEL OVERVIEW

To provide clarity, the key terms frequently used within this paper are defined below.

### Crop Revenue:

Commodity Price per Bushel × Crop Yield (Bushels per Acre)

### Crop Insurance Proceeds:

Indemnity payments for a revenue protection plan with an 80 percent coverage level.

### Government Payments:

Per acre payments from the federal government directly related to crop production, excludes CRP payments and conservation payments.

### Crop Costs:

The sum of per acre costs related to fertilizer, seed, pesticides, dryer fuel, machinery fuel, machinery repairs, hauling, interest, utilities, general farm insurance, crop insurance, machinery ownership, and family and hired labor.

### Cash Rent:

The market price paid per acre to rent farmland.

### Net Return to Land:

Crop Revenue per Acre + Government Payments per Acre + Crop Insurance Proceeds per Acre – Crop Costs per Acre (excluding land).

Additional detail pertaining to the items defined above is contained in the data section below. To quantify the relationship between cash rent and net return to land in Indiana, a simple econometric model is utilized. The model is as follows:

(1) $R_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 NRL_{t-1} + \beta_3 T + \mu_t$

where *t* is time period t, T is a time trend, R is cash rent, and NRL is net return to land. It is necessary to use lagged net return to land since when landowners are determining cash rent for the current year, the previous year's net return represents the most recent information. Additionally, lagged cash rent is a useful variable because of the sticky nature of cash rent values; that is, landowners are unwilling to make large changes in cash rent annually. Although this is almost identical to the model utilized by Featherstone and Baker (1988), it improves upon their results by expanding the analysis from Tippecanoe County to the entirety of Indiana and adding a variable representing the time trend. This time trend, T, depicts the influences of unknown variables affecting the value of cash rent, thus improving the statistical accuracy of the model. This paper also improves upon Featherstone and Baker's (1988) work by running regressions using real values of cash rent and net returns to land for low, medium, and high productivity land.

One of the issues that arises when using time series data sets such as those used in this paper is stationarity. An augmented Dickey-Fuller test can be used to check for the presence of a unit root. If a unit root is present, a time series is highly persistent and the sum of the assumptions associated with the estimation of equation (1) will be violated (Wooldridge, 2012). An augmented Dickey-Fuller test was conducted for each land productivity regression. If a unit root was discovered to be present, a first difference model was estimated. The first difference model can be expressed as follows:

(2) $\Delta R_t = \gamma_0 + \gamma_1 \Delta R_{t-1} + \gamma_2 \Delta NRL_{t-1} + v_t$

Short-term and long-term adjustment coefficients are computed for each regression. The short-term adjustment coefficient is represented by the coefficient on lagged net return to land or the change in lagged net return to land depending on whether a unit root exists. The long-term adjustment coefficient is computed by multiplying the coefficient on lagged net return to land (change in lagged net return to land if a unit root exists) by one minus the coefficient on lagged cash rent (change in lagged cash rent if a unit root exists). Short-term and long-term adjustment coefficients are analogous to short-run and long-run marginal propensities to consume (see Langemeier and Snider (2009) for a discussion of short-run and long-run marginal propensities to consume).

## DATA

This paper utilizes a 50/50 corn/soybean rotation to compute net return to land for low, medium, and high productivity land. Land productivity categories were based on potential crop yields. Specifically, low productivity referred to the southeast region of Indiana. Medium productivity was represented by the north, northwest, and southwest regions of Indiana and high productivity was represented by the west central and central regions of Indiana.

Crop revenue per acre is calculated by multiplying the commodity price per bushel for corn and soybeans by the yields for corn and soybeans. Data from USDA-NASS (*Quick Stats*), are used to determine commodity prices and yields for corn and soybeans. The value of crop insurance indemnity payments for corn and soybean production is obtained from author computations (Langemeier, 2015). These computations assume producers utilize an 80 percent revenue protection plan (Schnitkey, 2017). Government payments for corn and soybean production are obtained from three separate sources. The first source of data on government payments is from USDA-NASS (*Quick Stats*) and contains information on the total value of government payments made in each Indiana county from 1990 to 2002. This data set includes government payments related to the Conservation Reserve Program (CRP). CRP payments (USDA-FSA) are subtracted out of the total government payments to obtain the government payments for corn and soybeans used in this paper. The second source of data comes from Purdue's annual Crop Cost & Return Guides from 2003 to 2013 (Purdue Crop Guide Archive). The third source of data originates from ARC-CO government payments related to corn and soybean production for each county in Indiana for the years of 2014 and 2015 (USDA-FSA). Average government payments during the study period ranged from \$37 to \$40 per acre for low, medium, and high productivity land. Government payments were the lowest in 2013 (\$0 per acre) and were over \$100 per acre for each land productivity category in 2000 and 2001.

Crop production costs for corn and soybeans from 1990 to 2015 are estimated using the 2015 Purdue Crop Cost & Return Guide (Dobbins et al., 2015) and USDA price indices (USDA-NASS, *Agricultural Prices*). To account for seeding rate changes in corn production over time, an index is created using data from USDA-NASS (*Quick Stats*) on corn plant populations per acre in Indiana.

The dataset used to determine the value of cash rent from 1990 to 2015 within the state of Indiana originates from the Purdue Agricultural Economics Report (Purdue Agricultural Economics Report, Land Values Archive). This report aggregates cash rent data for different qualities of land by region in Indiana.

Finally, the GDP implicit price deflator is used to compute real cash rents and net returns to land by productivity category. The last year of the data set, 2015, is used as the base year for these computations.

Table 1 presents real gross revenue, production cost, cash rent, and net return to land per acre for the three land productivity categories. Other income includes government payments and crop insurance indemnity payments. Crop revenue comprises approximately 89 percent of gross revenue for low productivity ground, and 92 percent of gross revenue for medium and high productivity ground. Machinery cost includes fuel, repairs, and ownership costs. Labor cost includes family and hired labor. Miscellaneous cost includes dryer fuel, utilities, hauling, interest, general insurance, and crop insurance. Earnings per acre, obtained by subtracting cash rent from net return to land, is also presented in the table. Earnings per acre are negative for each land productivity category indicating that over the study period not all cash and opportunity costs were covered.

Net return to land was considerably more variable than cash rent over the study period. The coefficient of variation (computed by dividing the standard deviation by the mean) for the net return to land for low, medium, and high productivity land was 0.55, 0.51, and 0.44, respectively. In contrast, the coefficient of variation for cash rent for low, medium, and high productivity land was 0.14, 0.19, and 0.19, respectively. These coefficients of variation suggest that movements in the net return to land and cash rent are not one to one (i.e., a \$1 movement in net return to land does not necessarily correspond with a \$1 movement in cash rent). Figure 1 illustrates that relationship between cash rent and net return to land for high productivity land.

## RESULTS

The results of the econometric models represented by equation (1) are presented in Table 2. These results indicate a significant and positive relationship between cash rent and lagged net return to land. The coefficients on lagged net return to land range from 0.0502 for low productivity land to 0.1038 for medium productivity land, which are consistent with the coefficient on lagged net return to land found by Featherstone and Baker (1988) using data from 1960 to 1985. The lagged cash rent coefficients are positive and significant for each land productivity category. The relatively larger coefficient for the high productivity land suggests that cash rent is more persistent for this land productivity category. The time trend was also positive and significant for each land productivity category.

The augmented Dickey-Fuller tests (Z statistic in Table 2) indicate that a unit root is present for all three of the land productivity regressions in Table 2. The first difference results are presented in Table 3. The coefficients on the first difference of lagged net return to land range from 0.024 to 0.076. However, the F-statistic for low productivity land is not significant. The 0.076 and 0.074 coefficients on lagged net return to land for medium productivity land and high productivity land indicate that a $100 per acre change in net return to land results in a $7.60 and $7.40 per acre change in the subsequent year's change in cash rent, respectively, for medium and high productivity land. The coefficient on lagged cash rent is significant for high productivity land. This coefficient indicates that a $10 per acre change in lagged cash rent results in a $7.70 per acre change in the subsequent year's cash rent.

The short-term and long-term adjustment coefficients in response to a change in net return to land are presented in Table 4. The short-term adjustment coefficient in Table 4 represents the coefficients on lagged net crop returns in the regressions illustrated in Table 3. The short-run adjustment coefficient for low productivity land is not shown in Table 4 because the coefficient on lagged net return to land for this land category was not significant in Table 3. The long-term adjustment coefficients were computed using the regression coefficients on the lagged net return to land and lagged cash rent coefficients. The coefficients depicting long-term cash rent adjustments are only shown for the cases in which the coefficients related to lagged net return to land and lagged cash rent in Table 3 are significant.

The short-term adjustment coefficient for medium productivity land category was 0.076. Using the short-term adjustment coefficient, a $100 drop in net return to land per acre would result in a $7.60 per acre drop in cash rent in the subsequent year. The coefficient on lagged cash rent for the medium productivity land category is insignificant. As a result, the long-term impact on the medium quality land category is unknown. For the high productivity land category, the short-term and long-term adjustment coefficients are 0.074 and 0.323. Using the short-term adjustment coefficient, a $100 drop in net return to land per acre would result in a $7.40 per acre drop in cash rent in the subsequent year, which is very similar to the drop for medium productivity land. The long-term coefficient indicates that a permanent drop of $100 in net return to land per acre would result in a drop of $32.30 per acre in cash rent for the high productivity land category. Using the coefficients on short-term and long-term adjustment coefficients for high productivity land, only 23 percent of the total adjustment in response to a drop in net return to land occurs in the first year.

## CONCLUSIONS AND IMPLICATIONS

This paper examined the empirical relationship between cash rent and net return to land in Indiana. The results indicate a positive relationship between cash rents and net return to land. The low F-statistic exhibited for the low productivity land regression indicates that factors other than net return to land and lagged cash rent drive the value of cash rent for low productivity land in Indiana. The relatively low coefficients for lagged net return to land in the regressions for the medium and high productivity land suggest that cash rent values are sticky, that is, landowners are unwilling to make large changes in annual cash rent.

Using the coefficients on lagged net return to land in our empirical models, a $100 drop in net return to land per acre would result in a drop in the subsequent year's cash rent of approximately $7 to $8 per acre for medium and high productivity land. The significant coefficient on lagged cash rent for high productivity land suggests that the impact of a drop in net return to land would have a long-term impact on cash rent for high productivity land. The long-term impact of a $100 drop in net return to land per acre for high productivity land on cash rent was estimated to be approximately $32 per acre.

This paper explored the relationship between cash rent and net return to land with relatively aggregate data. Further analysis that uses more micro level data would be helpful. Specifically, matching cash rent and net return to land data for individual parcels or farms would provide robustness checks for the results in this paper.

## REFERENCES

Dobbins, C.L., M.R. Langemeier, W.A. Miller, B. Nielsen, T.J. Vyn, S. Casteel, B. Johnson, and K. Wise. 2015. "2015 Purdue Crop Cost & Return Guide." Purdue Extension, March.

Featherstone, A., and T. Baker. 1988. "Effects of Reduced Price and Income Supports on Farmland Rent and Value." *North Central Journal of Agricultural Economics*. 10(July):177–189.

Featherstone, A.M., M.R. Taylor, and H. Gibson. 2017. "Forecasting Kansas Land Values Using Net Farm Income." *Agricultural Finance Review*. 77(Issue 1):137–152.

Food and Agricultural Policy Research Institute 2018. *U.S. Baseline Outlook*, FAPRI-MU Report #01-18, March 2018.

Langemeier, M. "Crop Insurance Guarantees." Center for Commercial Agriculture, Purdue University, February 2015.

Langemeier, M., and L. Snider. "Marginal Propensity to Consume for a Sample of Kansas Farms." Selected paper presented at the Southern Agricultural Economics Annual Meeting in Atlanta, Georgia, January 31–February 3, 2009.

Purdue Agricultural Economics Report, Land Values Archive. https://ag.purdue.edu/commercialag/Pages/Resources/Farmland/Land-Prices/PAER-Archive.aspx [Accessed January 11, 2017].

Purdue Crop Guide Archive. https://ag.purdue.edu/commercialag/Pages/Resources/Management-Strategy/Crop-Economics/Crop-Budget-Archive.aspx [Accessed January 11, 2017].

Schnitkey, G. "Revenue Protection (RP) Use on Corn in the Midwest." Farmdoc daily (7):2, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, January 4, 2017.

United Stated Department of Agriculture, Farm Service Agency. 2016. *ARC/PLC Program Data*. https://www.fsa.usda.gov/programs-and-services/arcplc_program/arcplc-program-data/index [Accessed January 11, 2017].

United States Department of Agriculture. Farm Service Agency. 2016. *Conservation Reserve Program Statistics*. https://www.fsa.usda.gov/programs-and-services/conservation-programs/reports-and-statistics/conservation-reserve-program-statistics/index [Accessed January 11, 2017].

United States Department of Agriculture. National Agricultural Statistics Service. *Agricultural Prices*, various issues.

United States Department of Agriculture. National Agricultural Statistics Service. 2016. Quick Stats. https://quickstats.nass.usda.gov/results/5b45736d-d5a6-3966-b0e6-c216519f4d42 [Accessed Various Dates].

Wooldridge, J.M. 2012. *Introductory Econometrics: A Modern Approach*. Fifth Edition. Mason, OH: South-Western.

**Table 1. Average Gross Revenue, Production Costs, Cash Rent, and Net Return to Land in Indiana.**

| | | Low Productivity | Medium Productivity | High Productivity |
|---|---|---|---|---|
| **Gross Revenue (per acre)** | | | | |
| | Crop Revenue | 423 | 470 | 511 |
| | Other Income | 50 | 42 | 46 |
| | | | | |
| **Production Costs (per acre)** | | | | |
| | Fertilizer | 73 | 77 | 81 |
| | Seed | 49 | 52 | 54 |
| | Pesticides | 37 | 37 | 37 |
| | Machinery | 107 | 107 | 107 |
| | Labor | 39 | 39 | 39 |
| | Miscellaneous | 54 | 57 | 60 |
| | | | | |
| **Cash Rent and Net Return to Land (per acre)** | | | | |
| | Net Return to Land | 113 | 142 | 179 |
| | Cash Rent | 121 | 158 | 186 |
| | Earnings | -8 | -16 | -6 |

Notes: Data were for the 1990 to 2015 period. Low, medium, and high productivity categories were based on potential crop yields.

**Table 2. Cash Rent Model Results by Land Quality Category.**

| | Variable | Low Productivity | Medium Productivity | High Land Productivity |
|---|---|---|---|---|
| | Intercept | 36.73** | 19.55** | 3.01 |
| | NRLt-1 | 0.0502*** | 0.1038*** | 0.1010*** |
| | Rt-1 | 0.5335*** | 0.7078*** | 0.8513*** |
| | Time Trend | 1.0891*** | 1.0166*** | 0.6855*** |
| | F(3,21) | 65.29 | 179.01 | 339.06 |
| | Prob > F | 0.0000 | 0.0000 | 0.0000 |
| | Adjusted R2 | 0.889 | 0.957 | 0.977 |
| | Z(t) | 0.044*** | 0.141*** | 0.915*** |

Notes: * depicts 10% significance level; ** depicts 5% significance level; and *** depicts 1% significance level. Low, medium, and high productivity categories were based on potential crop yields.

**Table 3. First Difference Cash Rent Model Results by Land Quality Category.**

| | Variable | Low Productivity | Medium Productivity | High Land Productivity |
|---|---|---|---|---|
| | Intercept | 2.377 | 2.556 | 0.723 |
| | Δ NRLt-1 | 0.024 | 0.076*** | 0.074*** |
| | Δ Rt-1 | -0.126 | 0.287 | 0.771*** |
| | F(2,21) | 1.03 | 6.62 | 17.47 |
| | Prob > F | 0.3731 | 0.0059 | 0.0000 |
| | Adjusted R2 | 0.003 | 0.589 | 0.589 |

Notes: * depicts 10% significance level; ** depicts 5% significance level; and *** depicts 1% significance level. Low, medium, and high productivity categories were based on potential crop yields.

**Table 4. Short-Term and Long-Term Adjustment Coefficients in Response to a Change in Net Return to Land.**

| | Time Frame | Low Productivity | Medium Productivity | High Land Productivity |
|---|---|---|---|---|
| | Short-Term | N/A | 0.076 | 0.074 |
| | Long-Term | N/A | N/A | 0.323 |

N/A = not applicable (i.e., regression coefficients were not significant)
Note: Low, medium, and high productivity land categories are based on potential crop yields.

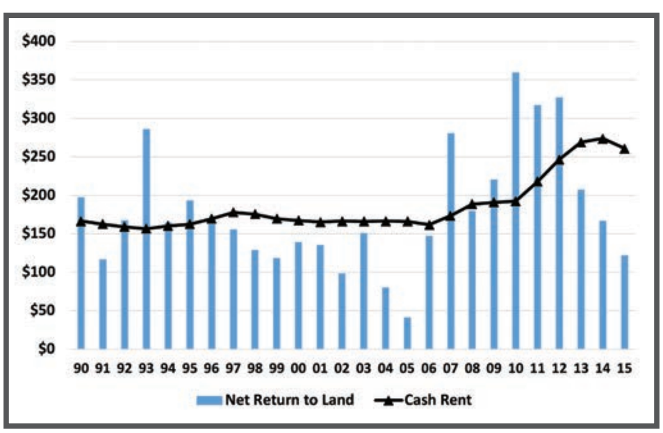
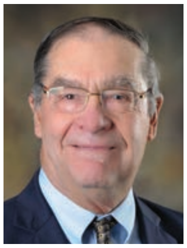



Figure 1. Cash Rent and Net Return to Land, High Productivity Land in Indiana

# Surprise Moment Management




**By D. Howard Doster, Gregory Ibendahl, Nathan Thompson, and Tyler Mark**

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## Abstract

*Many farm managers use either cross sectional benchmarks or time series benchmarks to help their clients make decisions and find areas of improvement. However, because most benchmarks are produced once a year, at the end of a year, this technique runs the risk of spotting problems or opportunities too late to help a farmer. There is another technique that relies on comparing a farmer's actual results to his or her projected results. A technique called "surprise moment" management may help a farmer identify and act on these problems and opportunities much more quickly than traditional methods. This paper describes such a method of managing at the moment and discusses how it could be used on an actual farm.*

## INTRODUCTION

When working as a farm manager, there are several approaches one can take to help farmers improve their profitability on a farm. Benchmarking against representative or similar farms and benchmarking against a farmer's historical performance are two common techniques (Langemeier, 2018). The two largest farm management associations, the Illinois Farm Business Farm Management (IFBFM, 2019) association and the Kansas Farm Management Association (KFMA, 2019) both use these methods when their field staff work with farmers. Benchmarking against representative farms provides a farmer with a cross sectional view, while benchmarking with a farmer's historical numbers provides a time series view. Both of these approaches provide valuable information to the decision maker, but the specific measure being benchmarked ultimately determines the appropriateness of cross sectional versus time series perspectives.

A more traditional management model (Kay, Edwards, & Duffy, 2016) has four primary functions: Planning, Implementation, Control, and Adjustment. After the adjustment function, new information is gathered that then flows back into the planning function. Conventional benchmarking approaches fit into this traditional model of management. The financial ratios and other information provided by benchmarking would fit into the control and adjustment functions and help producers as they make plans for next year. The weakness of the traditional model with benchmarking for farm management decisions is that decision-making comes down to a once a year, end of year process.

Another technique is to compare a farmer's actual performance against his or her planned performance. There are two possible variations of this technique; a 4-step method examining various alternatives and a 10-step method termed "surprise moment management with a plan." Both of these methods help producers discover problems and opportunities as they arise, rather than waiting for the year to end before discovering that a problem exists. Thus, both of these methods can help producers stay out in front of problems or show them new opportunities before those opportunities go away. Because of this earlier identification of problems and opportunities, this technique provides additional flexibility that traditional benchmarking does not.

The purpose of this paper is to examine both the more traditional 4-step method and the 10-step "surprise moment" method to see how they are similar and to see how the techniques could be used. A specific tool to implement the surprise moment method of management is not specifically discussed, but the approach necessary to implement the system is addressed.

## DESCRIPTION OF MANAGING AGAINST A PRODUCER'S PLANNED PERFORMANCE

### 4-Step Method

The 4-step method consists of asking farmers to complete four statements about their farming operations

1) The problem/opportunity is...

2) The cause of the problem or the reason for the opportunity is...

3) Alternative solutions and the likely consequence of each are...

4) Of those alternatives that are acceptable to me, my most and least preferred are...

This method is less mathematical and is based more on expert advice/opinions. To be used effectively, producers need to work with either a farm management expert or a board of the farmer's peers. We have found boards consisting of a pair of similar farmers work well. However, the farmers should not be in a situation where they would compete for land.

With this method, farmers have another resource for making decisions. Farming can be a complicated business, and it is doubtful that every farmer is an expert on every topic. However, many farmers are likely an expert in at least one area of farming. With a board of farmers, the area of expertise is broader and stronger than it was with just a single farmer. Thus, better decisions are potentially made, and farmers will be aware of more opportunities if multiple farmers are watching and providing input.

### 10-Step Surprise Moment Method

In this paper a "surprise moment" is an unexpected change in a farmer's livestock inventories, an unexpected change in prices, an unexpected change in the farmer's goals, or other new problems or opportunities that arise and require a modification to farm assets. Thus, this management technique is different from benchmarking in which problems are usually identified at the end of the year, as the problems and opportunities are identified and acted upon in real time.

The steps are:

*Understand steps*

1) Anticipate opportunities and monitor farm performance until a surprise is observed

2) Evaluate the symptoms

3) Identify the problem

4) Determine the cause

5) Reappraise the farm assets

6) Revise goals if needed

*Predict steps*

7) Test alternative plans to determine the consequences

*Change steps*

8) Identify the best plan

9) Implement the best plan

10) Monitor performance and look for the next surprise

## IMPLEMENTATION OF SURPRISE MOMENT MANAGEMENT

To accomplish the steps, a farmer needs to have a clear picture of the farm business so that decisions can be made the moment a "surprise" occurs. Farmers also need to anticipate opportunities so that surprises are recognized when they occur. Fundamentally, this includes a strategic plan, which provides a picture of where the farm is currently, where we want the farm to go, and how we plan to get there. Detailed vision and mission statements, as well as goals and objectives, provide the lens through which we view these various surprises as they arise. Other strategic planning tools, such as internal and external analyses and scenario planning, proactively establish how we view ourselves and the market in which we operate. Such tools allow us to rehearse our response to various future surprises.

In addition, this requires a farmer to project for more than one year at a time so that surprises are identified whenever actual performance starts to deviate from projected plans. This type of analysis requires more than just a set of financial statements. First, a farmer needs to appraise all assets at market value and not depend on the book value of assets. Book values are useful for time series benchmarking but less so when responding to problems that are occurring or responding to new opportunities for the farm. Market values also need to be estimated for each year of the planned life of the asset. As the plan progresses across time, the market values of all assets will be adjusted to account for current conditions.

Second, a farmer needs to calculate a contribution margin life cycle budget for each alternative and active set of enterprises. These contribution margins are the revenues over variable expenses. Fixed expenses are handled in the yearly projected balance sheets as explained later. Instead of calculating a budget for a single enterprise, a contribution margin life cycle budget calculates the contribution to farm equity on a per acre basis or a per head basis, or perhaps some other unit of comparison (e.g., field or irrigation circle or rented land from one landlord, etc.) for the complete cycle of enterprises to be grown or raised on that unit. For example, a farmer growing corn and soybeans in rotation on their land would calculate the contribution to equity over a two-year period from the combination of corn the first year and soybeans the second year. These life cycle budgets can then be converted into a yearly value to fit into the projected balance sheets (discussed next).

Finally, calculate the series of projected balance sheets by integrating all the life cycle budgets into a whole farm plan. At this point, the long-term assets are incorporated into the model. To effectively use this plan, enough years of projected balance sheets must be included to cover the life span of most machinery assets. For each year, the change to equity is calculated, and net present value analysis is used to project how the current set of alternatives is working.

As an example, a 20-year planning horizon is chosen, as that would encompass several life cycles of most of the farm assets. The life cycle budgets for each enterprise combination are calculated, and the potential yearly contribution to equity is added to the projected yearly balance sheets. Assets values at projected market value are added for each of the years. By taking the present value of the additions to yearly equity, a farmer can see how the present plan is working and what would happen if a change were made to the operation. If set up properly, a cash flow analysis can also be conducted.

Various alternatives can be examined using the same framework. Keep in mind that this approach does not fully incorporate risk, so a farmer would need to weigh their estimated equity changes with the risk of enterprises chosen.

## DISCUSSION

Traditional benchmarking with cross sectional farms as used by the several farm management associations across the country, or time series benchmarking against a farmer's historical production, certainly have their place. These benchmarks help a farmer identify problem areas and point them to where they should look within their business. However, because these benchmarks are usually only produced at the end of the year, farmers may be late in identifying problems. Also, traditional benchmarking does not address whether a farmer should add or trade assets. Farm management associations help address this deficiency with benchmarking by providing one-on-one consultations with farm management experts to help farmers examine any changes to their farm business. Also, many of the farm management associations provide the end of the year counseling to help manage taxes and cash flow.

The surprise moment management method helps a farmer respond to problems and opportunities earlier than a benchmarking method by looking for deviations to the farmer's own plans. As soon as prices or yields change or a new opportunity presents itself, a farmer can see how the new reality matches against his or her earlier plan. A farmer can thus respond at the time the event occurs rather than after the fact. Also, a properly set up surprise moment management plan can address new opportunities and the adding or trading of assets.

By developing a projected set of balance sheets that incorporate the enterprise alternatives and the farm assets, the surprise moment method also makes it easier to account for asset changes properly. As shown in Perrin (1972), replacing a “defender” asset with a new “challenger” asset can be complicated. With the assets incorporated into a series of projected balance sheets, farmers can follow the basic principles of Perrin but in an easier to use a balance sheet framework.

One possible limitation of the surprise moment method is that there could be a large number of alternatives to consider. This is especially true because of the multiple years involved. Thus, a computerized method, either a series of spreadsheets or a database, is helpful to implement this method.

Both the 4-Step and the 10-step surprise moment method can assist farmers in responding more quickly to problems or new opportunities. The 4-Step method requires outside consultation, while a single farmer can use the 10-step approach.

## REFERENCES


Illinois Farm Business Farm Management Association. (2019). http://www.fbfm.org/.

Kay, R., W. Edwards, & P. Duffy. (2016). *Farm Management*. McGraw Hill

Kansas Farm Management Association. (2019). https://www.agmanager.info/kfma.

Langemeier, M. (2018). “What Should My Farm Benchmark?” *farmdoc daily* (8):167.

Perrin, K.R. (1972). “Asset Replacement Principles.” *American Journal of Agricultural Economics – AMER J AGR ECON*. 54. 10.2307/1237734.

# Submission Guidelines

## PURPOSE OF THE JOURNAL

The Journal is published by the American Society of Farm Managers and Rural Appraisers. The Society decided in 2003 to move from hard copy format to online publication, although you may obtain a hard copy from the American Society headquarters for the cost of reproduction.

The Journal of the American Society of Farm Managers and Rural Appraisers is a refereed journal. Articles submitted for publication undergo a peer review process before being accepted for publication. The peer review process is designed to ensure that articles meet certain standards and that the Journal is a publication of high standing.

The Journal seeks articles from those working in all the fields of farm management, rural appraisal, and agricultural consulting. Therefore it is not just for academics, but is also open to contributions from all those involved in rural property valuation and/or management and consulting endeavors.

The purpose of the Journal is to provide a forum for those in the farm management, rural appraisal, and agricultural consulting fields, to share experiences with others, from which we can all learn.

## OBJECTIVES

**The objectives of the Journal are to:**

**1.** Present papers relevant to farm managers, rural appraisers, farm advisors, consultants, academics, students, and to all others interested in farm management, rural appraisal and agriculture in its widest sense.

**2.** Report new challenges and pressures that are developing, for the use of agricultural and rural resources.

**3.** Encourage practical and problem solving contributions highlighting common farm management, rural appraisal, and agricultural consulting issues and principles.

## AUTHOR GUIDELINES FOR SUBMITTING MANUSCRIPTS

Contributors MUST use the following guidelines in preparing manuscripts for submission:

**1. Cover letter.** In a cover letter accompanying the manuscript, (a) indicate why the manuscript would interest JASFMRA readers; (b) certify that the material in the submitted manuscript (or modification thereof) has not been published, is not being published, and is not being considered for publication elsewhere; and (c) stipulate that the material in the manuscript, to the best of the author's knowledge, does not infringe upon other published material protected by copyright.

**2. Title page.** On a separate page, provide the title of the manuscript and author(s)' name(s) centered and in boldface type. At the bottom of the same page, provide university title(s), institutional affiliation(s), acknowledgments of colleague reviews and assistance, and institutional support as an unnumbered footnote. If there are multiple authors, please designate which author is the contact, and include contact's address, phone number, and e-mail address. *Do not place the name(s) of the author(s) on the first page of the text.*

**3. Abstract.** Include an abstract of 100 words or less.

**4. Manuscript Title.** Manuscript titles should not exceed 10 words, should encompass the topic of the paper, and should be designed to attract potential readers.

**5. Style, Grammar, and Punctuation.** The JASFMRA uses The Chicago Manual of Style by the University of Chicago Press, and Webster's Third New International Dictionary for style, format, and spelling.

**6. Manuscript Format Guidelines.**

a. Manuscripts should not exceed approximately 5,000 words and must be submitted electronically.

b. Use left justification only.

c. Double-space all material throughout the manuscript, including abstract, acknowledgments, footnotes, and references.

d. Use 12-point Times New Roman font style throughout.

e. Allow 1" margins on all sides. Do not use right-justified margins (i.e., use jagged right margins).

f. Do not use end-of-line hyphenation feature.

g. All pages and lines must be numbered. Line numbers are to run consecutively throughout the entire manuscript from page one to the end of the manuscript; **do not** re-start numbers on each page.

h. You must use Word for your manuscript.

i. Excel should be used for spreadsheets, tables, and graphs.

**7. Footnotes.** Number footnotes consecutively throughout the manuscript. Combine all footnotes on a separate page immediately following the manuscript text. *Do not place footnotes at bottoms of manuscript pages.* Footnotes should be used solely for citations or directives to other literature. Reference citations should be incorporated into the main text or into the text of the footnotes.

**8. References/Text Citations.** In a reference section immediately following the footnotes page, list all works cited in the text, alphabetized by author last name. Refer to The Chicago Manual of Style for format. For within-text citations (either parenthetical or as part of narrative), spell out up to three author last names; use first author's name followed by "et al." for works with four or more authors. When citing a direct quotation, include page number(s) from the author's work. List complete URLs for online sources.

**9.** Figures and Tables. Place each figure and table on a separate page at the end of the manuscript. Computer-generated graphics for figures and charts are required, Microsoft Excel versions of every table, chart, and figure must accompany submission. Do not place figure title/caption within graphics image. Use patterns rather than color where possible.

**10. Photos.** Photos and graphics must be sent as separate files. Resolution should be 300 dpi. Preferred format is JPEG; TIFF and PDF image files also accepted.

**11. Math/Equations.** *Use only essential mathematical notation.* Consecutively number equations throughout the text. When displaying equations, place equation number within parentheses at flush-left margin; center the equation. Use italic typeface for all variables, both within equations and within narrative.

**12. Publication Costs.** Authors submitting manuscripts are expected to assume obligation for payment of page charges at the time their manuscripts are published. Current page charges are $95/printed page for non-members and $80/page for ASFMRA members but may be waived if authors do not have institutional support.

**13. Manuscript Deadline:** August 15th of each year is the deadline to submit a manuscript for publication in the following year's Journal.

**14. The Editorial Review Process.**

a. The Chair of the ASFMRA Editorial Committee, serving as Editor, assesses the initial suitability of articles submitted.

b. Authors of submissions considered to be potentially suitable for the JASFMRA will be notified and their paper sent to three members of the ASFMRA Editorial Committee, who will review the article for the Editor.

c. Unsuitable articles are returned to the authors with a short note of explanation from the Editor. *Failure to adhere to the Manuscript Format Guidelines will be cause for the manuscript to be returned to the authors.*

d. The review process is double-blind: the identity of the author(s) remains anonymous to the reviewer and vice versa.

e. Following review, authors may be asked to resubmit their article in revised form.

f. Upon completion of the review and editorial processes, authors will be notified of the Editor's decision regarding publication along with explanatory feedback, including referees' reports. The lag between receipt of submission and first response varies, but a turnaround of four months should be expected. We will make every effort to ensure that this target is achieved, but it cannot be guaranteed.

g. Final decisions will be made at the Editorial Committee's annual meeting, generally in the fall of each year. The decision of the Editor is final.

**15. Submissions.** Electronic submission of manuscripts is required and must include the lead author's email address. The manuscript must be formatted per above guidelines as a Word attachment to the ASFMRA, Attn: Alex Clark.

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