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Factors Contributing to Earnings Success of Cash Grain Farms

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ABSTRACT

The objective of this study was to identify factors which contribute to the earnings' success of cash grain farms in the United States. The study analyzes three measures of success including net farm income per dollar of asset, operators' returns to labor and management, and operators' management income. Logit regression analysis shows that controlling variable costs, ownership, management ability, technology adoption, and diversification are important factors that influence success.

Key Words: *cash grains, diversification, earnings success, logit regression.*

The structure of U.S. agriculture has shifted steadily toward bigger and fewer farm businesses. Published data from the U.S. Department of Agriculture show that the current number and the average size of farm stands at 2 million and 470 acres, respectively. This is compared with nearly 6.8 million farms that existed in 1935 with an average size of 155 acres (Jones and Canning and *Agricultural Statistics,* USDA). An interesting issue, given this downward trend in farm numbers, is what makes some producers/farmers more successful than others. In other words, what is the likelihood that a farm will have above-average returns and be a successful business in years to come. With agriculture potentially becoming less dependent on federal subsidies, the potential for increased variability of returns due to the vagaries of weather or the volatility of commodity prices is likely to have an impact on the sector.

Under the 1996 Federal Agricultural Improvement and Reform Act (FAIR, 1996), production flexibility contract payments remain fixed regardless of prices (*see* Nelson and Schertz, 1996 for more detail). As a result, many farmers will face greater risk of income volatility, reflecting market variations more directly. Essentially, the government carries little risk under the 1996 FAIR Act while farmers who participated in commodity programs face greater risk. To manage the risk shifted to farmers, individuals will have to develop a risk-management strategy best suited for their farms (for example, hedge or use futures markets, forward-contract crop sales, reduce debt/increase savings and equity, use market information and analysis, or increase education). Farmers will select strategies to improve farm production efficiency, risk management, and overall returns/profits in order to be successful in their farming business. A better understanding of the characteristics that influence returns and/or profits would be useful to producers who wish to make changes in their farming operations in order to increase returns, and to

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policymakers who aim at formulating policies that help farmers maintain stable incomes.

The purpose of this study is to identify factors that contribute to success on commercial grain farms in the United States, using farm level data. The success of a farm is assumed to be reflected in the farm's profitability as estimated by three measures: (1) modified net farm income per dollar of assets (MNFIDOA); (2) operators' labor and management (OLMI); and (3) operators' management income (OMI). To control for extraneous factors that may influence the results, the analysis is conducted by farm type, specifically, for cash grains.

Data Description

Data for the analysis is from the 1994 Agricultural Resource Management Study (ARMS) also formerly known as Farm Costs and Returns Survey. The ARMS, conducted annually by the Economic Research Service and the National Agricultural Statistics Service, is a multiframe stratified survey with the sample being drawn from a stratified list and area frame. The ARMS is composed of several questionnaire versions (for technical documentation, see Morehart, Johnson, and Banker). The survey collects data to measure the financial condition (farm income, expenses) and operating characteristics of farm businesses, the cost of producing agricultural commodities, and the well-being of farm operator households. The survey design of the ARMS allows each sampled farm to represent a number of farms that are similar, the total number of farms being the survey expansion factor. The *expansion factor,* in turn, is defined as the inverse of the probability of the surveyed farm being selected (U.S. Department of Agriculture, 1991).

The Farm Operator Resource version (FOR) is dedicated to the collection of special data on farm and farm operator households. In 1994 the FOR collected information on business contacts by farm operators, management decisions, sources of information, use of technology, management strategies, and off-farm employment. The 1994 ARMS also collected information on the importance of the financial conditions of the farm. Financial condition is measured by asking about the importance of expanding the business, reducing the debt, reducing the costs, moderating fluctuation of prices received for products, keeping records for financial analysis.

The 1994 FOR version of the ARMS provided information on farmers' use of various marketing, production, and financial strategies. Farmers were given a list of strategies and asked to identify their uses.[1] About 40 percent of all farm operators indicated that they employed at least one financial strategy.[2] About the same proportion of farm operators also used some marketing strategy.[3] About 55 percent of all farm operators indicated that they used at least one production strategy.[4] The 1994 FOR also asked the farmers to describe their use of new technologies. The farm operators were given five choices: (1) I wait to try new technologies until they are proven by other operators in my county, (2) I use about the same technologies as other operators in my county, (3) I am willing to try new technologies even though only few other operators in my county use those technologies, (4) I am usually the first in my county to try new technologies, and (5) None of the above. Thirty-eight percent of farmers indicated that they used the same level of technology as other farmers in their county. Twenty-one percent indicated that they tried new technologies even though only a few other farmers used them, and only three percent said that they were usually the first to try new technologies.

Previous Studies

A descriptive approach has been used to analyze the relationship between profits and farm

[1] Responses included: has used, will use again; have used, probably won't use again; have not used; and does not apply.

[2] Examples include: maintaining an open line of credit, keep cash on hand, renegotiate loans, and matching loan maturity terms with sales of products.

[3] Some examples of marketing strategies include: hedging or use of futures, contracting the sale of farm products, and spread sales over the year.

[4] Examples include: diversification; insurance (crop and livestock); leasing land, machinery, and equipment; and use of custom work and contracting inputs.

characteristics (e.g. Johnson *et al.*; Reimund and Somwaru; and Strickland). They all suggest that characteristics such as farm size, location, and cash grain production were positively related to a measure of profit. On the other hand, factors such as when the primary occupation of the operator is not farming, age of the operator, and livestock production were all negatively related to a measure of farm profitability. Reinsel and Joseph suggest that commodities produced, location, size of operation, management, and natural phenomena are factors that cause returns to vary.

Several studies have examined the relationship between profit and farm characteristics (e.g. Garcia, Sonka, and Yoo; Wood, Johnson, and Ali; and Ali and Johnson). Kauffman and Tauer (1986), using farm level data from New York dairy farmers, investigated the characteristics of a successful dairy farm. They identified successful farms using first-degree and second-degree stochastic dominance techniques for a panel of 112 dairy farms. Using logit regression they determined important characteristics leading to farm success. They concluded that maintaining high milk production, controlling hired labor and purchased feed expenses, and adopting new technology selectively were key to financial success. Managerial ability generally is considered a key determinant of financial success in farming. Sonka *et al.* (1989) used managerial ability as a measure of farm performance to identify successful and less successful farms (cash grain farm in Illinois). They used logit regression to identify the factors that affect farm financial performance and concluded that price of the output and yield were important factors. Plumley and Hornbaker (1991) used different financial ratios to measure the financial success of Illinois cash grain farms. They used Kauffman and Tauer's (1986) technique to group the farms into successful and less successful categories. Their findings show that successful farms are characterized by higher liquidity, fairly balanced composition of assets, lower debt, and higher profitability.

Risk management strategies (for example, hedging, use of futures market, and insuring the crops and livestock) adopted by farmers could affect their financial performance and hence improve the farm's probability of success. It is well known that farming is a risky business,[5] with much uncertainty about yield and price, and strategies to deal with that uncertainty are important. Previous studies have investigated agricultural producers' perspectives on the importance of different sources of risk as well as the management practices farmers adopt to reduce those risks (Boggess *et al.*, 1985; Perry *et al.*, 1995; Perry and Johnson, 1996; and Patrick, 1984). Planning and risk management strategies continue to play an increasing role in providing returns to farmers. Holt and Brandt (1985) list numerous studies that show hedging can reduce risk. They point out that if farmers are sufficiently risk averse, they should hedge even if hedging may lower average prices. Curtis *et al.* (1987) conclude that in some cases farmers' use of selective hedging strategies resulted in increased income, while reducing the risk. Shapiro and Brorsen (1985), in a study of Indiana farmers, found that farmers perceive hedging to both increase income and improve income stability. However, Fazier (1984) points out several factors—such as lack of understanding, fear of margin calls, and basis risk—that are responsible for a low participation rate in hedging market by farmers. Also, hedging is not used because the volume required by the trade is not low enough for most farmers to participate.

Periods of greater commodity price variability, greater exposure to world supply and demand conditions through open trade policies (for example, NAFTA, and GATT), and a more market-oriented farm policy (FACT Act of 1990 and FAIR Act of 1996) have placed and will continue to place increasing attention on commodity marketing. This increased attention had led to the development of alternative marketing strategies (Paul *et al.*) These include futures and options markets for agricultural commodities such as wheat, feed

[5] Barry (1984) identified five sources of business risk in agriculture: production or technical risk, market or price risk, technological risk, legal and social risk, and human sources of risk.

grain, soybean, and cotton. Newbery and Stiglitz (1981) suggest that farmers' use of futures markets may be influenced by exposure to risk, transactions costs, size of operation, whether or not their commodity is continuously stocked, and the cost of information. However, they point out that the use of futures markets is not as prevalent because futures markets are only effective in stabilizing incomes over a short period. Alternative methods of reducing marketing and production risk are also available. These include forward contracting, price support programs (Ali and Johnson and Wood, Johnson and Ali), crop insurance, and spreading sales over the year.

Unlike previous research, this study provides a national perspective and allows for the introduction of risk behavior in the analysis. Our research is unique because it uses national farm-level data and measures the probability of success of a farm in an era where farmers will assume greater market risk. Results will provide farmers and policy makers a better understanding of the factors that will affect farm viability in the future.

Methodology and Model Specification

The appropriate measure of economic success has been a topic of much interest among economists and accountants. Some would argue that accrual net farm income (before taxes) is a good measure of overall financial performance while others suggest that returns to labor and management is the better measure. Yet other researchers have used several financial ratios to measure farms' financial performance (e.g. Plumley and Horbaker; Ellinger *et al.*). Kauffman and Tauer use labor management income per operator and rate of return on equity capital excluding appreciation as measures of farm performance.

Success is a subjective term and depends in part upon the time frame considered and the goals of the farm business and/or farm household. Therefore, the criteria by which a farm's performance is measured must be clearly defined.[6] Several studies have investigated the use of net farm income (NFI) as a performance measure (Melichar; Haden and Johnson; Seger and Lins). The benefits of using NFI, as a measure of profitability have been well documented in the past studies (Lins *et al.*, Seger and Lins). Positive value of NFI is critical to survival of the farm. Most farmers must balance equity growth with the need to meet short-term cash commitments. The use of NFI as a sole performance measure, however, may present a problem because it is an accounting measure which does not address opportunity costs. Hence the use of NFI as an economic performance measure does not necessarily accurately reflect use of the resource base. The measure is a dollar amount and it is therefore difficult to compare across farm businesses. Also, the form of business organization (family owned, corporation, etc.) can cause problems for interpretation of this result. However, we will use a modified net farm income per dollar of asset (MNFIDOA) as a performance measure. The modified farm income is defined in Table 1.

In light of the above problem, two additional measures are used: (1) operators' labor and management income (OLMI) and (2) operators' management income (OMI). Table 1 shows a precise specification of the computation of MNFI, OLMI, and OMI. OMI allows concentration on factors affected by management decisions and is defined as net farm income, less opportunity cost on total capital, and the return to non-operator labor (for example, unpaid workers such as farm operators' spouse and family members). This measure

[6] Based on financial guidelines set forth by the Farm Financial Standards Task Forces (FFSTF), financial performance refers to the results of production and financial decisions, over single or multiple periods (Forbes, 1991). FFSTF further notes that measures of financial performance such as NFI include the effect of external and uncontrollable forces (for example, drought, flood, and grain embargoes), and the results of operating and financing decisions made during the course of the production process. Because the net farm income measure is an absolute amount and is size-driven, any comparison across farm businesses that is based solely on this measure must be interpreted with caution.

Table 1. Computation of Modified Net Farm Income, Operators' Labor and Management Income, and Operators' Management Income

1. Modified Net Farm Income (MNFI)

MNFI = Net Farm Income (NFI) plus interest expense.

NFI = Gross farm income − total farm operating expenses
excludes marketing expenses

where

gross farm income = gross cash farm income + net change in value of crop, livestock, feed, and fertilizer inventory and accounts receivable + value of farm products used or consumed on the farm + gross imputed rental value of farm operators dwellings

and

total farm operating expenses = total cash operating expenses + estimate of non-cash expenses for paid labor (*includes feed, fuel, housing, meals and other food, utilities, water coolers, and vehicle for personal use*) + depreciation on farm business asset.

2. Operators' Labor and Management Income (OLMI)

where

OLMI = net farm income − charge to non-operator unpaid labor − charge to capital

and

charge to non-operator unpaid labor = {number of hours worked on farm} × {wage rate}

wage rate = NASS state average for all hired workers + social security tax for 1993

charge to capital = {networth} × {2.28%}

3. Operators' Management Income (OMI)

where

OMI = net farm income − charge to operator unpaid labor − charge to non-operator unpaid labor − charge to capital

and

charge to unpaid operator labor = {number of hours worked on farm} × {wage rate}

(OMI) may be deemed to be an appropriate indicator of operator performance over time because the success of a farming operation ultimately depends on the ability of the owner-operator to manage resources used in production. Decisions concerning the selection of farm enterprises, combination of farm inputs, and other financial exposure are eventually reflected in OLMI (See Alchian and Demsetz (1972) and Downey and Trocke (1981)).

In order to identify various characteristics of successful farm firms, a method is needed to differentiate between successful and less successful farm firms. Because of the data limitations, farms are classified based on each performance measure into two categories: less successful farms and more successful farms. The first subgroup includes farms whose financial performance was in the bottom three-fourths of the sample. The second subgroup is composed of those farms whose financial performance was in the top one-fourth of the sample.

After the more successful and less successful groupings were established, the characteristics of farm firms' production and management attributes responsible for this separation were investigated using a logistic regression.[7] We have adopted the logit model as originally suggested by Berkson (1944) and redefined by Theil (1970). Each farm was assigned a value of 1 or 0, according to its classification as more successful or less successful. Specifically, the logit is defined as the natural logarith-

[7] The logit model was selected primarily because the majority of the independent variables in our model are dichotomous which results in data being concentrated in the tails and in the probability distribution resembling a distribution based on a logistic function (see Kmenta). Also, we are measuring the likelihood of success given certain marketing, production, and management strategies used by farmers,.

mic value of the odds in favor of a positive response (in this case being a successful farm), that is:

$$(1) \quad L_{ij} = \log\left[\frac{P_{ij}}{1 - P_{ij}}\right] = \alpha + \beta' X_{ij},$$

where

$(i = 1, \ldots, n)$,

$(j = \text{MNFIDOA, OLMI, and OMI})$,

L_{ij} is the log-likelihood function that the ith farm is among the successful group of farms when the jth performance measure is used,

P_{ij} is the conditional probability of a farm being successful given the knowledge of X_{ij},

X_{ij} are set of farm operators', farm, and financial characteristics, and,

β' is a vector of parameters to be estimated.

$$P_{ij} = \frac{1}{1 + e^{-(\alpha+\beta X_{ij})}},$$

It can be shown that and one can use Equation 1 for estimation purpose. The independent variables hypothesized to affect the farm's financial performance which are chosen to encompass the three areas—farm operators' characteristics, farm characteristics such as production and marketing efficiency measures, and financial characteristics—are presented in Table 2.

The inclusion of farm operators' characteristics such as age and education may give some insights into the influence of training, experience, and demographics on farm business financial performance. These factors affect the production function (Huffman, 1980 and Becker, 1975). Education is hypothesized to have a positive effect on all three measures of success (MNFIDOA, OLMI, and OMI), as predicted by the human capital theory. Better educated farmers tend to be more successful and to receive the same or better returns from farming as elsewhere (Perry, 1990). Warren, using cross-classification analysis, found that operators of higher income dairy farms in New York had a higher-than-average level of education. Cunningham-Dunlop assessed the effect of education on farm profits in Canada. She concluded that the net returns to education in Canadian agriculture were positive. On the other hand, Laband and Lentz and Osburn found a negative effect of education on the financial performance of the farm.

Seven farm production characteristics are hypothesized to contribute to farms' financial performance: nonfarm income, machinery value per harvested acre, participation in government commodity programs, ratio of cash operating expenses, and diversification. Nonfarm income may affect labor and management. If the source of the nonfarm income is wages and salaries (in this study we use income from all other sources), then one would expect the effort expended to detract from farm labor and management, contributing to lower performance of the farm. Machinery value per harvested acre is expected to be negatively related to farm performance. Ali and Johnson used machinery expenses per tillable acre as a variable in explaining returns to labor and management. They found that this variable has a significantly negative influence on the labor earnings.

The variable ratio-of-cash-operating-expense to value-of-farm-production (COPEVP) is used to take into account the variable cost of production. Cash operating expenses include expenditure on labor, purchased feed and livestock, maintenance and repair, fertilizer and chemical, seed and plant and custom hire work. It is hypothesized that more successful farms will have a significantly lower ratio than less successful farms. Plumley and Hornbaker have used the COPEVP as the variable to study (using mean analysis) characteristics of successful and less successful Illinois grain farmers. Kauffman and Tauer and Haden and Johnson have used expenditures on hired labor to measure the same effect. Therefore, a negative relationship is hypothesized between COPEVP and the probability that a farm will be successful. Warren and Burritt in their study found that most profitable dairy

Table 2. Independent Variables for Logit Regression

Variable	Definition	Expected Signs
Operator's Characteristics		
HIGHSC	Level of formal education (= 1 high school, 0 otherwise)	?
SCOLL	Level of formal education (= 1 some college, 0 otherwise)	?
COLL	Level of formal education (= 1 completed college, 0 otherwise)	?
WORKOFF	Participation in off-farm work (= 1 working off-farm, 0 otherwise)	−
Farm Characteristics		
Production Characteristics		
PARTGOVT	Participation in govt programs (= 1 participated, 0 otherwise)	+
MEVPHAA	Value of machinery per harvested acre	−
COPEVP	Ratio of cash operating expense to value of farm production	−
DIVERSIF	Entropy measure of farm diversification	+
ORGAN	Type of business organization (=1 sole proprietorship, 0 otherwise)	
Management Practices		
FORWARD	Use of forward input pricing method (= 1 participated, 0 otherwise)	+
CONTRACT	Participation in contracted sale of crop and livestock (= 1 participated, 0 otherwise)	+
SPREAD	Participation in hedging/futures markets (= 1 participated, 0 otherwise)	+
WTECH	Adoption of technology (= 1 if waits to adopt proven technology, 0 otherwise)	?
SCTECH	Adoption of technology (= 1 if second to adopt technology, 0 otherwise)	?
FSTECH	Adoption of technology (= 1 if first to adopt technology, 0 otherwise)	?
EXTENSION	Use of farming information (= 1 uses extension service, 0 otherwise)	+
RENTLAND	Lease/rent land (= 1 leases/rents land, 0 otherwise)	+
KBKRC	Keeping books and records (= 1 records income/expenses, 0 otherwise)	+

farmers were controlling their cash expenses. Luckham focused on identifying financial ratios associated with profitability of Virginia dairy farms. He found that controlling operating expenses (which measures cost control) was positively related to profit. Korth used a variety of statistical techniques to identify factors related to financial success of Nebraska beef-hog, grain, and dairy farms between 1978 and 1982. He found that expense structure had a negative and significant impact on the financial success of the farm.

Diversification, as measured by an entropy index[8] (DIVERSIF) which was popularized by

[8] It is important to note the DIVERSIF takes a value of 1 when there is completely diversified and 0 when a farm is specialized (Samuelson 1967, Theil 1972).

Theil, is used as a explanatory variable in the model because of the several desirable properties it possesses (see Hackbart and Anderson). It is assumed that diversification may lead to economies of scope which lower costs and increases profit[9], thereby producing a greater probability that a farm will be more successful. Newbery and Stiglitz point out that crop diversification is one of the ways by which farmers can reduce risk and variability associated with farm income. Pearse, using regression analysis, found that among other things increased cropping intensity increased returns to operator labor. Kauffman and Tauer used diversification (value of crop sales/total cash receipts) as an explanatory variable to model the successful dairy farms in New York.

The ORGAN variable was used to indicate the form of business organization chosen for the farm operation, either sole proprietorship (or individually owned) or multi-owner forms (such as family held corporation, cooperative, and non-family corporation). This variable assumes a value of 1 if the farm was individually owned and 0 otherwise. Type of ownership is expected to be positively related to the farm's chances of being in the successful group if it is organized under sole proprietorship. On the other hand, the more people that contribute assets to the production process the greater the asset base to work from, resulting in a better financial performance. Therefore, one cannot predict the effect of ORGAN on the financial performance of the farm. Garcia *et al.* found that the degree of land-ownership by the operator was inversely related to short-run profit maximization. Burton and Abderrezak in their study of Kansas farms found that the proportion of non-ownership had positive correlation to expected profits. In contrast, Kauffman and Tauer in their study of successful dairy farms in New York conclude that the sole proprietorship form of business organization increased a farm's chances of success.

Managerial ability has been used in regression models as a set of demographic variables or production practices (Sumner and Leiby; Bailey *et al.*; Mykrantz *et al.*). Managerial practices in general have been found important to the success of farming operations (Sonka, Hornbaker, and Hudson). However, there is no clear consensus arising from previous studies on what variables represent management or accurately represent managerial ability. Ford and Shonkwiler used latent variables such as crop, financial, and dairy management practices to study financial success of dairy farms in Pennsylvania. Their findings show that management practices such as milk sold per cow, milk sold per individual, veterinary expenses per cow, and heifers and calves per cow are important determinants of farm financial success. Hoffman indicated that well-managed farms, based on farm records, are better able to compete in per-unit profitability with farms many times larger. In our study two variables are used as a proxy for management practices: (1) use of rented/leased land in production process and (2) keeping books and records on farm income and expenditures. It is hypothesized here that better managers tend to rent or lease land for production process instead of buying. Buying of land diverts available capital that could be used in the production process. On the other hand, keeping good records on the income and expenditure of the farm, and perhaps on each enterprise, may help the farm operator in allocating resources and time. This makes the operator more efficient and hence more profitable. In a recent article Crane notes that budget analysis can be used to identify and manage risk. Further, risk identification and management involves the understanding of enterprise and its components.

Pulter and Zilberman in their 1988 study point out that decision support application software (for example, ledger accounting, spreadsheet, and database management) helps in crop and livestock management, irrigation scheduling, and herd improvement. More recently, software is available that takes the farmer step by step in determining the consequences of various choices he/she makes under different financial and physical conditions. Kauffman and Tauer use hay ratio (haylage as

[9] Because this study uses cross-sectional data, as one reviewer noted, any significance of the DIVERSIF variable should be interpreted with caution.

a proportion of all hay) as a measure of technology adoption. They point out that farmers who adopted haylage production technology over dry hay significantly improved their farm's probability of success. The 1994 ARMS also surveyed farm operators about their use of new technologies. Based on their response, four categories (using dummy variables) were created as a measure of technology for use in the present study. First, farmers who indicated that they were the first one to adopt a new technology (FTECH) in their county were given a value 1, and 0 otherwise. Second, farm operators who indicated that they were willing to try a new technology even though it has been tried by only few operators in the county (SCTECH) were given a value of 1, and 0 otherwise. Third, operators who indicated that they would wait to try new technology until they were proven by other operators in the county (WTECH) were given a value of 1 and 0 otherwise. Finally, farm operators who indicated that they use about the same level of technology as other operators in the county and who did not indicate any level of use of new technologies (NOTECH) were given a value of 1, and 0 otherwise. This final category acted as a base group.

Table 3 presents the summary statistics of the data. In general, operators of successful farms were younger, except when the success was measured in terms of operators' management income. Operators of successful farms, on average, worked less off the farm. The percentage of farm operators reporting off-farm income was as low as 31 percent for successful farms and as high as 52 percent for less successful farms (Table 3). The characteristic that stands out is that more successful farms tend to have lower value of machinery per harvested acre, lower variable cost of production, higher participation rate in government programs, and tend to use more marketing and production contracts to mitigate risk in farming. More successful farms (28–32%) tend to use forward input contracting as means to reduce risk in input markets. More successful farms tend to use extension services for their information on farming and other related issues than their counterparts. Finally, approximately 62 percent of more successful farm operators tend to rent or lease land.

Results

Table 4 shows the parameter estimates for successful cash grain farms for three measures of success. In all of the measures, use of forward contracting in input markets by cash grain farms is positive and statistically significant at 1 percent level of significance. The results indicate that farms that adopt forward contracting of inputs are more likely to be successful, possibly indicating efficiency in resource use by the way of timely delivery of inputs and inventory control. Forward contracting of inputs could facilitate the planning process and allow farmers to diversify purchases over time (Haydu *et al.*). Having inputs in stock ensures smooth and efficient running of the business operation (Taha). Purchase price is of special interest when quantity discounts and price breaks can be secured.

Controlling the variable cost of production is another important variable that contributes to the success of farm firms. Our results, using all three measures of success, indicate that ratio of cash operating expense to value of production (COPEVP) is negatively correlated with the success of farm firms. Results indicate that farms which have controlled their cash operating expenses are more likely to be successful than farms which did not. These results are consistent with the findings of the past studies (Kaufman and Tauer, Haden and Johnson, Korth, Luckham, Sonka, Hornbaker, and Hudson, and Warren and Burritt). The sign on value of machinery per harvested acre (MEVPHAA) was negative but was only significant when success was measured in terms of modified net farm income per dollar of asset (MNFIDOA). Economically, it makes sense to have less capital tied up in machinery and one way of getting around machine ownership is to lease or custom hire the machinery needed in farm operations. Ali and Johnson obtained a similar result in their study of North Dakota farm operators.

In all three measures of success, farm own-

Table 3. Variable Definition and Mean Values

Variable Name	Variable Definition	MNFIDOA[1]		OLMI		OMI	
		SF[2]	LF[2]	SF	LF	SF	LF
AGE	Operator's age (years)	50	55	52	54	54	53
HIGHSC	Operator's level of education (= 1 high school, 0 otherwise)	0.43	0.40	0.41	0.40	0.45	0.40
SCOLL/some	Operator's level of education (= 1 some college, 0 otherwise)	0.22	0.21	0.23	0.22	0.21	0.21
		0.17	0.17	0.19	0.17	0.19	0.18
COLL	Operator's level of education (= 1 completed college, 0 otherwise)	0.35	0.51	0.32	0.52	0.41	0.49
		1.32	1.49	1.29	1.50	1.29	1.49
WORKOFF	Participation in off-farm work (= 1 participated, 0 otherwise)	0.51	1.68	0.51	1.69	0.45	1.70
MEVPHAA	Value of machinery/harvested acres (*$1,000*)						
COPEVP	Ratio of cash operating expenses to value of production						
DIVERSIF	Entropy measure of farm diversification	0.14	0.10	0.15	0.09	0.18	0.11
PARTGOVT	Participation in govt programs (= 1 participated, 0 otherwise)	0.59	0.37	0.63	0.35	0.56	0.37
ORGAN	Type of business organization (= 1 sole proprietorship, 0 otherwise)	0.88	0.92	0.86	0.92	0.86	0.92
CONTRACT	Participation in contracted sales of crop and livestock (= 1 participated, 0 otherwise)	0.33	0.16	0.37	0.14	0.27	0.17
SPREAD	Spread sales over the year (= 1 participated, 0 otherwise)	0.47	0.36	0.53	0.34	0.41	0.38
FORWARD	Participation in forward pricing of input contracts (= 1 participated, 0 otherwise)	0.28	0.12	0.32	0.11	0.25	0.13
WTECH	Adoption of technology (= 1 if waits to try proven technology, 0 otherwise)	0.34	0.39	0.34	0.39	0.33	0.39
SCTECH	Adoption of technology (= 1 if adopts unproven technology, 0 otherwise)	0.25	0.19	0.27	0.18	0.23	0.20
FTECH	Adoption of technology (= 1 if first to adopt unproven technology, 0 otherwise)	0.03	0.03	0.03	0.03	0.03	0.03
EXTENSION	Use of farming information (= 1 if tried extension service, 0 otherwise)	0.60	0.54	0.65	0.52	0.59	0.54
RENTLAND	Lease/rent land (= 1 rent, 0 otherwise)	0.62	0.40	0.60	0.40	0.49	0.44
KBKRC	Keeping books and records (= 1 if does own book/record keeping, 0 otherwise)	0.69	0.63	0.74	0.62	0.66	0.64

[1] Measures of farm success: MNFIDOA is modified farm income (MFI is a ratio of net farm income plus interest expenses to total assets; OLMI is defined as the operator's labor and management income; OMI is the operator's management income.

[2] SF denotes more successful farms and LF denotes less successful farms.

Table 4. Parameter Estimates of Factors Affecting Farming Success of Cash Grain Farmers (1994)

Variable	MNFIDOA	OLMI	OMI
Intercept	−0.471	−2.689	−0.443
	(0.896)	(0.752)***	(0.837)
HIGHSC	0.581	0.566	0.356
	(0.408)	(0.435)	(0.391)
COLL	0.854	0.092	0.102
	(0.899)	(0.677)	(0.689)
FORWARD	0.954	0.981	0.886
	(0.325)***	(0.319)***	(0.311)***
CONTRACT	0.395	−0.023	0.188
	(0.427)	(0.409)	(0.382)
SPREAD	0.471	0.729	0.242
	(0.321)	(0.379)*	(0.319)
SOLE	−0.861	−0.529	−0.574
	(0.326)***	(0.286)*	(0.326)*
DIVERSIF	1.987	1.198	4.196
	(1.234)*	(1.123)	(1.072)***
PARTGOVT	−0.565	1.328	0.576
	(0.377)	(0.498)***	(0.397)
MEVPHAA	−0.003	−0.0006	−0.0007
	(0.0008)***	(0.0004)	(0.543)
COPEVP	−2.853	−2.648	−1.507
	(0.807)***	(0.741)***	(0.674)***
STECH	0.329	0.361	0.319
	(0.329)	(0.341)	(0.328)
SCTECH	0.874	0.232	0.322
	(0.349)***	(0.366)	(0.372)
FTECH	−0.844	−0.530	−0.319
	(0.628)	(0.565)	(0.571)
EXTENSION	0.551	0.554	0.144
	(0.304)*	(0.303)**	(0.298)
RENTLAND	1.088	0.197	0.028
	(0.344)***	(0.379)	(0.321)
KBKRC	0.196	0.742	0.162
	(0.426)	(0.431)*	(0.506)
WORKOFF	0.194	−0.382	−0.328
	(0.289)	(0.285)	(0.196)*
F-Statistics	5.15**	5.27**	3.24*
McFadden's R^2	0.28	0.30	0.25
Sample	1101	1101	1101

Numbers in parentheses are standard errors. Single, double, and triple asterisks indicate statistical significance at 10%, 5%, and 1% levels respectively.

ership (SOLE) has the expected sign. Results indicate that farms owned by individuals are less likely to be successful than farms owned in partnership or corporations. A possible explanation of the negative linkage between farm business organization and likelihood of success is that more people contribute to the asset base and greater asset base means better financial performance of the farm firm. Farm diversification, as measured by the entropy index (DIVERSIF), has a positive sign but is only significant when success is measured by

modified net farm income per dollar of asset (MNFIDOA) and operators' management income (OMI). Results indicate that farmers who diversify are more likely to be successful than those who do not diversify. Diversification helps to smooth farm income, i.e., variance in returns is minimized as long as returns to different enterprises is imperfectly correlated (Newbery and Stiglitz). One of the other ways to spread risk and smooth income from farming is to spread sales of farm products over the year. Results show that spreading sales (SPREAD) over the year has a positive sign and is statistically significant in the case where farming success is measured by operators' labor and management income. Farm firms are more likely to be successful if they spread sales of their farm product over the year.

A farm operator may generate a higher total net income by combining on- and off-farm work, but when investigating the success of farm firms farm income mattered most. When measuring success in terms of operators' management income, results show that working off the farm decreases the likelihood of a farm's being successful. A possible explanation is that farm operators who work off the farm have less time to manage the farm, resulting in mismanagement of resources in the production process. In contrast, if one measures success by operators' labor and management income, participation in government programs increases the likelihood of a farm's being successful. A possible explanation for a positive correlation between participation in government programs and success is that participation in government programs gives farm operators time to better manage their time and resources.

The coefficient for EXTENSION is positive and statistically significant in two measures of success: modified net farm income per dollar of assets and operators' labor and management income. This result indicates that operators who use agricultural extension services are more likely to be successful. Visits to the agricultural extension services may allow farmers to increase their allocative efficiency (Hurd; Huffman). Additionally, operators who frequently visit extension offices may benefit from new technology (such as new varieties of seed, farm implements, and tools) and from getting quick answers to their farm problem. Furthermore, their visit may help in reducing their yield variance and in smoothing the flow of income.

Management strategies such as renting/leasing land (RENTLAND) for production and keeping books and record (KBR) on farm income and expenditures are important determinants of successful farms. Coefficient for RENTLAND is positive and statistically significant when success is measured by modified net farm income per dollar of assets (MNFIDOA). A positive possible explanation to the positive linkage between renting/leasing land and successful farming is that leasing/renting frees some capital resources from being tied up in land mortgage and interest payments. A significant positive relationship between keeping books and records and successful farming is found, but only when success is measured in terms of operators' labor and management income. Results suggest that farm operators who keep track of their income and expenditures through bookkeeping are more likely to be successful in their business. These results are consistent with Hoffman's findings. The influence that technology has on the chances for farm success is evident from this study. The coefficient on SCTECH is positive and statistically significant at 5 percent only when success is measured by operators' labor and management income. This finding indicates that operators who are not the first one to adopt a new technology (FTECH) in their county are more likely to be successful than those who use the same level or do not use new technology.

Conclusions

The purpose of this study was to identify factors that contribute to the success of commercial farms, in particular of cash grain farms. A logit analysis was used on data from the 1994 ARMS survey to measure the likelihood of a farm's being successful given its use of certain farm, operator, production, marketing,

and risk-management strategies. The study used three measures of success. In all the cases, returns to operators' labor and management performed well when compared with the other two.

The likelihood of a cash grain farm's being successful depends on its control of variable costs of production, machinery cost, and farm ownership. Risk management strategies such as forward contracting of inputs, spreading sales over the year, participation in government programs, and farm diversification also contributed toward the success of a farm. Use of new technology, especially after some one else has tried it out in the county, plays an important role in the success of a farm. Use of extension services increases the likelihood of a farm's being successful. Finally, management factors such as use of rented/leased land and keeping books and records on income and expenditure help operators to be efficient and eventually contribute towards the success of the farm.

References

Alchian, A.A. and H. Demsetz. "Production, Information Costs, and Economic Organization." *American Economic Review* 62,5(December 1972).

Ali, M.B., and R.G. Johnson. *Factors Influencing Economic Success of North Dakota Farms.* Agricultural Economics Report No. 223, North Dakota State University, June 1987.

Bailey, D.V., B. Biswas, S.C. Kumbhakar, and B.K. Schulthies. "An Analysis of Technical, Allocative, and Scale Inefficiency: The Case of Ecuadorian Dairy Farms." *Western Journal of Agricultural Economics* 14(July 1989):30–37.

Barry, P.J. (Ed.). *Risk Management in Agriculture.* Iowa State University Press, Ames, 1984.

Barry, P.J. and D.R. Fraser. "Risk Management in Primary Agricultural Production: Methods, Distribution, Rewards, and Structural Implications." *American Journal of Agricultural Economics* 58(1976):286–295.

Becker, G. S. *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education.* New York: National Bureau of Economic Research and Columbia University Press, 1975.

Berkson, J. "Application of the Logistic Function to Bio-Assay." *Journal of American Statistical Association* 39(1944):357–365.

Boggess W.G., K.A. Anaman, and B.D. Hanson. "Importance, Causes, and Management Responses to Farm Risks: Evidence from Florida and Alabama." *Southern Journal of Agricultural Economics* 17(1985):106–116.

Burton, R.O. Jr. and Ali Abderrezak. *Expected Profit and Farm characteristics.* Contribution No. 89–32-D Manhattan: Agricultural Experiment Station, Kansas State University, July 1988.

Crane, L., "Using Budget Analysis to Identify and Manage Risks." *Crop Insurance Today* 32,2(1999):9–13.

Cunningham-Dunlop, C. *A Five-Year Analysis of New York Egg Farm Management Factors.* Agricultural Economic Research 82–18. Ithaca: Department of Poultry and Avian Sciences, Cornell University, June 1982.

Curtis. C.E., G.H. Pfeiffer, L.L. Lutgen, and S.D. Frank. "A Target MOTAD Approach to Marketing Strategy Selection for Soybeans." *North Central Journal of Agricultural Economics* 9(1987):195–206.

Downey, W.D. and J.K. Trocke. Agribusiness Management. New York: McGraw-Hill, 1981.

El-Osta, H.S. and M.C. Ahearn. *Estimating the Opportunity Cos of Unpaid Farm Labor for U.S. Farm Operators.* Technical Bulletin # 1848, Economic Research Service, U.S. Department of Agriculture, Washington D.C., 1996.

Ellinger, P.N., P.J. Barry, T.L. Frey, and J.T. Scott, Jr. *Financial Characteristics of Illinois Farms 1985–1986.* University of Illinois at Urbana-Champaign, Department of Agricultural Economics, 1987.

Forbes, Stan (Chairman). *Recommendations of the Farm Financial Standards Task Force: Financial Guidelines for Agricultural Producers.* Financial Accounting Standards Board, Norwalk, Connecticut, 1991.

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

Frazier, J.H., Jr. "Commentary." *Review of Research in Futures Markets* 4,1(1984):29–30.

Garcia, P., S.T. Sonka., and M.S. Yoo. "Farm Size, Tenure, and Economic Efficiency in a sample of Illinois Grain Farms." *American Journal of Agricultural Economics* 64(1982):119–123.

Haden, K.L. and L.A. Johnson. "Factors Which Contribute to Financial Performance of Selected Tennessee Dairies." *Southern Journal of Agricultural Economics* 21(1989):105–112.

Hackbart, M.M. and D.A. Anderson. "On Measuring Economic Diversification': Reply." Land Economics 54(1978):111–112.

Haydu, J.J., R.J. Myers, and S.R. Thompson. "Why Do Farmers Forward Contract in Factor Markets?" *Southern Journal of Agricultural Economics* 24,145(1992).

Hoffman, Robbin. "Size and Profitability: It's Better to Be Good than Big, But You Can't Beat Good and Big." *Farm Journal(Mid-March 1996)*:2–3.

Holt, M.T. and J.A. Brandt. "Combining Price Forecasting with Hedging of Hogs: An Evaluation Using Alternative Measures of Risk." *The Journal of Futures Markets* 5(Fall 1985):209–309.

Huffman, W.E. "Farm and Off-Farm Work Decisions: The Role of Human Capital." *Review of Economics and Statistics* LXII(1980):14–23

Hurd, B.H. "Yield Response and Production Risk: An Analysis of Integrated Pest Management in Cotton," *Journal of Agricultural Resources Economics* 19,313(1994).

Johnson, J.D., R. Prescott., D. Banker., and M. Morehart. *Financial Characteristics of U.S. Farms., January 1, 1986.*Washington D.C. AIB-500, Economic Research Service, U.S. Department of Agriculture, August, 1986.

Jones, J., and P. N. Canning. *Farm real Estate: Historical Series Data, 1950–1992.* SBN-855, Washington DC, USDA-ERS, 1992.

Kmenta, Jan. *Elements of Econometrics* (2d edition), Macmillian Publishing Company, New York, 1971.

Kauffman, J., B., and L.W. Tauer. "Successful Dairy Farm management Strategies Identified by Stochastic Dominance Analysis of Farm Records." *Northeastern Journal of Agricultural and Resource Economics* 15(1986):168–77.

Korth, B. D. Factors for Determining Financial Success for Farm Managers. Unpublished M.Sc. Thesis: University of Nebraska, Lincoln, November 1984.

Laband, D., N., and B.F. Lentz. "Occupational Inheritance in Agriculture." *American Journal of Agricultural Economics* 65(1983):311–314.

Lins, D., P. Ellinger, and D. Lattz. "Measurement of Financial Stress in Agriculture." *American Finance Review* 47(1987):43–52.

Luckham, W. R. "Financial Ratios for Grade A Dairy Farms in Virginia." *Farm Credit Administration Research Journal* 1(1976):18–24.

Melichar, Emanuel. "Capital Gains versus Current Income in the Farming Sector." *American Journal of Agricultural Economics* 61(1979):1085–1102.

Morehart, M. J., J. D. Johnson, and D.E. Banker. *Financial Performance of U.S. Farm Businesses, 1987–1990.* Washington DC. AER-66, Economic Research Service, U.S. Department of Agriculture, August, 1986.

Mykrantz, J. L., L.G. Hamm, and L. J. Connor. "An Analysis of Selected Management Practices and Demographic characteristics of Michigan Dairy Farms." Agricultural Economics Report No. 537. Department of Agricultural Economics, Michigan State University, July, 1990.

Nelson, F. And L. Schertz (eds.). Provisions of the Federal Agricultural Improvement and Reform Act of 1996, AIB, U.S. Department of Agriculture, Economic Research Service, Washington DC, 1996.

Newbery, D.M.G. and J. Stiglitz. *The Theory of Commodity Price Stabilization.* Chapters 12 and 13, Oxford: Clarendon Press, 1981.

Osburn, D. D. "An Analysis of Factors Influencing Loan Losses Among Production Credit Association." *Farm Credit Administration Research Journal* 3(1978):18–24.

Paul, A.B., R.G. Heifner, and J.D. Gordon. *Farmers' Use of Cash Forward Contracts, Futures Contracts, and Commodity Option.,* U.S. Department of Agriculture, Economic Research Services, Washington DC, December AER 533, 1985.

Patrick, G.R. "Producers' Attitudes, Perception and Management Responses to variability." In *Risk Analysis for Agricultural Production Firms: Concepts, Information Requirements and Policy Issues.* Department of Agricultural Economics, University of Illinois; AE-4574, July, 1984, 197–256.

Pearse, R.A. "A Study of Relationships Used in Farm Record Analysis." Research Bulletin 911. Columbia, Agricultural Experiment Station, University of Missouri, 1966.

Perry, J.E. Returns to Labor from Farm and Non-Farm Employment. Unpublished Ph.D. Dissertation, Department of Agricultural Economics, Oklahoma State University, Stillwater, 1990.

Perry, P.E., J.D. Johnson, and M.J. Morehart."Farmers' Risk Management Strategies." Economic Research Service, Briefing Paper, Rural Economy Division, ERS, U.S. Department of Agriculture, Washington DC, 1995.

Perry, P.E., J.D. Johnson. "Management Decisions Made by U.S. Farmers." *Discussion Paper,* Presented at AAEA Annual Meetings, July 28–31, 1996 San Antonio, TX.

Pindyck, R., and D. Rubenfeld. *Econometric Models and Economic Forecasts* (3d edition). New York: McGraw-Hill, 1991.

Plumley, G.O., and R.H. Hornbaker. "Financial Management Characteristics of Successful Farm Firms." *Agricultural Finance Review* 51(1991): 9–20

Pulter, D.S. and D.A. Zilberman. "Computer Use in Agriculture: Evidence from Talure County, California." *American Journal of Agricultural Economics* 70(1988):790–802.

Reinsel, R.D., and A. Joseph. The Financial Condition of Agriculture: An Income Analysis. Washington DC: ERS Staff Report AGES860710, Economic Research Service, U.S. Department of Agriculture, August, 1986.

Reimud, D.A., and A. Somwaru. Farm Income by Type of Farm 1982 and 1983. Washington D.C. Staff Report AGES860710, Economic Research Service, U.S. Department of Agriculture, August, 1986.

Samuelson, P. "A General Proof That Diversification Pays." *Journal of Financial Quantitative Analysis* 2(1967):1–13.

Seger, D.J., and D.A. Lins. "Cash Versus Accrual Measures of Farm Income." *North Central Journal of Agricultural Economics* 8 (1986): 219–226.

Shapiro, B.I. and B.W. Brorsen. "Factors Affecting Farmers' Hedging Decision." *North Central Journal of Agricultural Economics* 10 (1985): 145–153.

Simpson, W. And M. Kapitany. "The Off-Farm Work Behavior of Farm Operators." *American Journal of Agricultural Economics* 65 (1983): 801–805.

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(1989):39–47.

Strickland, R.P. "The Negative Income of Small Farms." *Agricultural Economics Research* 1(1983):52–55.

Sumner, D.A., and J.D. Leiby. "An Econometric Analysis of the Effects of Human Capital on Size and Growth Among Dairy Farms." *American Journal of Agricultural Economics* 69 (1987):465–70.

Theil, H. "On the Estimation of Relationship Involving Qualitative Variables." *American Journal of Sociology* 76 (1970):103–154.

Theil, H. *Statistical Decomposition Analysis,* North-Holland, Amsterdam, 1972.

U. S. Department of Agriculture. *Agricultural Statistics,* National Agricultural Statistical Service, Washington DC, various issues.

U. S. Department of Agriculture. *Economic Indicators of the Farm Sector: Costs of Production-Major Field Crops and Livestock and Dairy,* 1991. ECIFS 11–3, Feb. 1994.

U. S. Department of Agriculture. *"Farmers' Use of Marketing and Production Contracts."* Agricultural Economics Report, # 747, Economic Research Services, Washington D.C. December 1996.

Warren, G. F., and M. C. Burritt. *The Incomes of 178 New York Farms.* Bulletin 271, Ithaca: Cornell University, 1909.

Warren, S. W. *Factors for Success of Dairy and General Farms in Northern Livingston County, New York.* Bulletin 242 Ithaca: Cornell University, 1932.

Wood, M.A., R.G. Johnson, and M.B. Ali. *Performance Factors and Management Practices Related to Earnings of East Central North Dakota Crop Farms.* Agricultural Economics Report No. 224, North Dakota State University, August 1987.