Factors Affecting the Profitability of Limited Resource and Other Small Farms

Ashok K. Mishra, Hisham S. El-Osta, and Cheryl J. Steele

The authors are agricultural economists with the Economic Research Service, U.S. Department of Agriculture, Washington, DC. The views expressed here are not necessarily those of the Economic Research Service or the U.S. Department of Agriculture. The authors appreciate the helpful comments and suggestions of two anonymous reviewers. Constructive comments offered by the editor are also gratefully acknowledged. Any remaining errors are the responsibility of the authors.

Abstract

This study investigates the factors affecting profitability of limited resource and other small farms. Profitability is measured by net farm income and operators' labor and management income. The empirical model is estimated by a weighted least squares procedure using data from the USDA's 1996 "Agricultural Resource Management Study" survey. Results indicate that profitability of limited resource farms depends on operator's age, soil productivity, debt-to-asset ratio, and ratios of variable and fixed costs of production to value of agricultural production. Profitability of other small farms depends on operator's age, farm size, farm diversification, and crop insurance. Further, a major source of variation in the performance measures of both limited resource and other small farms is the ratio of variable costs to value of agricultural production.

Key words: limited resource farms, net farm income, operators' labor and management income, profitability
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Despite a two-thirds decline in the number of farms since 1945, farm businesses with gross sales of less than $250,000 remain important contributors to rural economies and U.S. agriculture. These farms, which are referred to as small farms by the National Commission on Small Farms [U.S. Department of Agriculture (USDA) 1998], constitute 90% of U.S. farms, own 67% of farm land, and hold 77% of the farm sector’s net worth. They also contribute significantly to rural economies as purchasers of inputs and supplies, and preservers of the rural landscape. Additionally, many small farm operators also work in nonfarm jobs.

Under the 1996 Federal Agriculture Improvement and Reform (FAIR) Act, farmers face greater risk of income volatility because of the likelihood of increased volatility in prices received by farmers. Unstable income will affect the financial position of many farms, and may even force some to exit farming. Particularly vulnerable are the marginal operations with low production efficiency, and those that are highly leveraged.

A better understanding of which farm and operator characteristics influence profitability would be useful to operators of limited resource farms and other small farms who wish to make changes in their operations in order to increase profit, and to policy makers who seek to design policies aimed at increasing the incomes of these farming operations.

The small farms category includes farms that differ in terms of both the level of their commitment to farming and in their capacity to earn income. A large percentage of these farms (44%) is comprised of those where the farm operator is either retired, or resides on the farm because of the lifestyle it provides and farming is not the operator’s primary occupation.

The remainder of the farms in the small farms group consists of those where the major occupation of the
operator is farming. A recently constructed typology of U.S. farms (see Hoppe) separates this particular category of small farms into three groups: (a) limited resource farms (i.e., gross sales under $100,000, farm assets under $150,000, and farm operator household income under $20,000); (b) "low-sales" farms (i.e., farm sales under $100,000, but more assets and/or income than the limited resource farm); and (c) "high-sales" farms (i.e., farm sales are $100,000 to $249,999). Our study will focus on limited resource farms (LRFs), and on other small farms (OSFs)—which combines the "low-sales" and "high-sales" groups defined above.

The objective of this study is to assess factors hypothesized to affect the profitability of limited resource and other small farms. This objective is achieved by using weighted multiple linear regression where a measure of profitability is regressed against \( k \) independent variables that describe the characteristics of the farm and the operator. Once the functional relationships between the profitability measure and the \( k \) independent variables are estimated, hypotheses tests related to estimated parameters are utilized to isolate the variables deemed important to the profitability of LRFs and OSFs. Also, the concept of the coefficients of separate determination is used to investigate how much of the variation in profitability is explained by the \( k \) dependent variables.

**Literature Review**

Studies by Tweeten and Amponsah, and Madden and Tischbein report that not only are small farms a heterogeneous group, but types within the group are affected differently by the commodity produced. Tackie, Findlay, and Baharanyi recently explored the farm product marketing perceptions and practices of limited resource farmers in south central Alabama. Their study points out that increased sales volume and concentration on high-value products could increase profitability, and hence farm income.

Gebremedhin and Christy used census data to show that changes in production agriculture have important implications for resource use, population distribution in rural areas, and the survival of small farms. They note that structural change in production agriculture is due to economic and technological adjustments and that the adjustment is not temporary. Their study is limiting in two areas. First, it does not differentiate limited resource farms and fails to recognize that "small farms" is a heterogeneous
group. Second, no empirical analysis is conducted to investigate the profitability of the small farms.

Fox, Bergen, and Dickson provide a comprehensive summary and analysis of studies, spanning the period 1948-88, that have examined farm financial performance (in terms of profitability and viability). Various analyses have examined the factors affecting financial performance of commercial cash grain and dairy farms in specific regions and states of the U.S. (Sonka, Hornbaker, and Hudson; Haden and Johnson; El-Osta and Johnson; Kauffman and Tauer; Lazarus, Streeter, and Jofre-Giraudo; and Langemeier, Schroeder, and Mintert). A descriptive approach has been used to analyze the relationship between profits and farm characteristics (e.g., Johnson, Prescott, Banker, and Morehart; Reimund and Somwaru; and Strickland). These studies suggest that characteristics such as farm size, location, and cash grain production were positively related to a measure of profit. Conversely, livestock production and age of operator were negatively related to a measure of farm profit. Reinsel and Joseph found that commodities produced, location, size of operation, management, and natural phenomena are factors that cause returns to vary.

A number of additional studies (e.g., Garcia, Sonka, and Yoo; Wood, Johnson, and Ali; and Ali and Johnson) also have investigated the relationship between profit and farm characteristics. Several farm production characteristics are hypothesized to contribute to farms' financial performance: machinery value per harvested acre, participation in a crop insurance program, ratio of cash operating expenses to value of agricultural production, managerial practices, business organization, and diversification. Machinery value per harvested acre is expected to be negatively related to farm performance. In fitting a returns to labor and management model, machinery expense per tillable acre was used by Ali and Johnson as one of the explanatory variables. Their findings indicate a negative and significant correlation between machinery expense per tillable acre and labor earnings.

Plumley and Hornbaker used the ratio of cash operating expense to value of farm production as a variable to study (using mean analysis) characteristics of successful and less successful Illinois grain farmers. Kauffman and Tauer, and Haden and Johnson also used expenditures on hired labor as an explanatory variable. Warren and Burritt found that most profitable dairy 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 employed 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 reported that expense levels had a negative and significant impact on the financial success of the farm operation.

Managerial practices in general have been found important to the financial performance of farming operations (Sonka, Hornbaker, and Hudson). However, previous studies provide no clear consensus as to what variables represent management, or how to accurately portray managerial ability. Ford and Shonkwiler used latent variables such as crop, financial, and dairy management practices to study financial performance of dairy farms in Pennsylvania. Their findings show that such management practices as milk sold per cow, milk sold per man, veterinary expenses per cow, and heifers and calves per cow are more important determinants of farm financial success than financial management (e.g., equity-to-asset ratio, operating margin, and debt per cow) or crop management (e.g., crop acres per cow, crop acres per man, and crop expenses per acre). Hoffman indicated that well-managed farms, based on farm records, are able to compete in per unit profitability with farms many times larger.

In their study of successful dairy farms in New York, Kauffman and Tauer concluded that the sole-proprietorship form of business organization increased a farm's chances of success. Newbery and Stiglitz noted that crop diversification is one of the ways in which farmers can reduce the risk and variability associated with farm income. Pearse, using regression analysis, found that increased cropping intensity raised returns to operator labor.

Purdy, Langemeier, and Featherstone found contradictory evidence when they examined the financial performance of a sample of Kansas farms. Specifically, they reported that certain specializations, such as swine, dairy, and crop production, increased mean financial performance. However, specialization in beef production decreased mean financial performance. The authors also concluded that farms with both crop and livestock enterprises had less variability in financial performance.

Model Specification ___
Consider a risk-neutral farm operator who is a price-taker and a profit-maximizing agent. During each production period, the farm operator selects the combination of inputs and products that will maximize the difference between revenue ($TR$) and costs ($TC$) subject to a production function. A farm operator’s planning problem may be stated mathematically as:

$$\text{Max } \Pi = TR - TC$$

$$= \sum P_i Q_i (K, P_i, \alpha)$$

$$- [\sum C_j (Q_i, r_j, \beta) + FC].$$ \(1\)

where $\Pi$ is net profits, $P_i$ denotes product prices, and $Q_i$ denotes quantities of each product produced. Production depends on the farmer’s level of human capital, $K$ (i.e., experience, level of education); price of output, $P_i$; and other farm characteristics, $\alpha$ (such as soil productivity and type of business organization). On the other hand, $C_j$ represents the cost of production. Cost of production of a commodity depends on quantity of outputs produced, $Q_i$; input prices, $r_j$; and a vector of farm and operator characteristics that affect the production function, $\beta$. Finally, $FC$ represents fixed costs of the production process.

Based on the conceptual model in equation (1), limited resource and other small farms’ financial performance ($FP$) is hypothesized to be a function of farm and operator characteristics. Specifically, we estimate the following equation using a weighted least squares procedure:

$$FP_i = \gamma_0 + \sum_{k=1}^{5} \gamma_k X_{ki}$$

$$+ \gamma_6 \text{SOLE}_i + \gamma_7 \text{RECORD}_i$$

$$+ \gamma_8 \text{CROPINS}_i + \epsilon_i,$$ \(2\)

where $FP_i$ denotes either net farm income ($NFI$) or operators’ returns to labor and management ($OLMI$) of the $i$th farm ($i = 1, \ldots, n$). These two measures of financial performance are described below. $X_1X_5$ denote age, age squared, debt-to-asset ratio, soil productivity, and value of agricultural production (an indicator of size), respectively. $X_6$ represents the variable cost of production. In particular,
it is the ratio of cash operating expense\(^2\) to value of agricultural production\((VCOPVP)\). It is hypothesized that more successful farms will have a significantly lower ratio of variable costs to value of agricultural production than will less successful farms. \(X_7\) represents the fixed cost of production. In our analysis we use the ratio of fixed costs to value of agricultural production as a measure of fixed costs\((FCOPVP)\). \(X_8\) denotes degree of diversification\((DIVERSIF)\) as measured by an entropy index\(^3\) which was popularized by Theil. It is assumed that diversification may lead to economies of scope, thereby lowering costs and increasing profit. The \textit{SOLE} variable indicates the form of business organization (i.e., sole proprietorship, family-held corporation, cooperative, or nonfamily corporation) chosen for the farm operation. This variable assumes a value of one if the farm was organized as a sole proprietorship, and zero for all other forms of organization. In our study we use a dummy variable\((RECORD)\) as a proxy for management practices. The \textit{RECORD} variable takes a value of one if the farm operator kept a ledger book, record book, or account book on farm income and expenditures, and zero otherwise. Keeping good records on the income and expenditures of the farm (and perhaps on each enterprise) may help the farm operator in allocating resources and time to activities that warrant the most attention. This practice contributes to the operator's efficiency, and hence profitability. Finally, if the farmer used crop insurance, then the variable \textit{CROPINS} takes a value of one, and zero otherwise.

\(^1\)A soil productivity index, ranging from 0 to 100, is used— with zero representing the least productive soil and 100 representing the most productive soil. (See Pierce, Larson, Dowdy, and Graham for details.)

\(^2\)Cash operating expenses include expenditure on labor, purchased feed and livestock, maintenance and repair, fertilizer and chemicals, seeds and plants, and custom hire work.

\(^3\)It is important to note that \textit{DIVERSIF} takes a value of one when a farm is completely diversified, and zero when a farm is specialized (Samuelson; Theil). Further (as one reviewer noted), since this study uses cross-sectional data, any significance of the \textit{DIVERSIF} variable should be interpreted with caution.

One of the factors that determines whether a farm will survive is the ability of the farm operator to generate profit (Boehlje and Eidman). The appropriate measure of financial performance has been a topic of much debate among economists. The Farm Financial Standards Task Force (FFSTF) has recommended 16 financial measures for analyzing farm finances. Of these, four are suitable for examining the financial performance of the farm business: net farm income, rate of return on assets, rate of return on equity, and net profit margin.\(^4\)
Based on financial guidelines set forth by the Farm Financial Standards Task Force, financial performance refers to the results of production and financial decisions over single or multiple periods (Forbes).

In the farming business, most farmers must balance equity growth with the need to meet short-term cash commitments. Net farm income (NFI), which measures income on an accrual basis, is used by farmers to make decisions on business expansion or contraction and to judge the financial success of the business relative to other investment and employment opportunities. NFI is the most commonly used measure of the ability of a farm enterprise to meet short-term (year-to-year) cash commitments. Additionally, lenders base their decision (at least in part) on the past and projected net farm income or profitability of the business to which they are lending money.

While the benefits of using NFI as a measure of profitability are well documented (see Melichar; Lins, Ellinger, and Lattz; Seger and Lins; Haden and Johnson), its use as a sole performance measure is problematic because it does not address the opportunity costs of utilized resources (e.g., equity capital, and operator and family labor). Another limitation of using NFI is the fact that it includes both the effects 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 NFI is an absolute amount and is size-driven, and because of all of the other limitations surrounding its use, any comparison across farm businesses that is based solely on this measure must be interpreted with caution.

Although the three other measures of financial performance recommended by FFSTF (rate of return on assets, rate of return on equity, and net profit margin) are for the most part more suited than NFI for comparison among farms of different sizes and types, they remain limiting in that the reliability of their estimates hinges on the ability to correctly value the opportunity costs of operators' unpaid labor—a task that is heavily dependent on the availability of certain information that pertains to operators' off-farm labor work hours and off-farm earnings, operators' education, etc. (see El-Osta and Ahearn).5

5Currently, the USDA approach is to value farm operators' unpaid labor based on the individual state's average wage rate for hired workers.

In light of the above problems associated with NFI, operators' labor and management income (OLMI) also is used to measure performance6 (see Alchian and Demsetz;
Downey and Trocke). The advantage of using OLMI is that the cost of equity capital is explicitly deducted, leaving a measure that solely represents operators' management performance.

Another potentially useful performance measure that has been widely used in the farm management literature is that of management returns (Boehlje and Eidman; Sonka, Hornbaker, and Hudson).

**Variability of Financial Performance**

After performing the weighted least squares estimation using the jackknife method (for detail, see Gray and Schucany, and Dubman), the contribution of the explanatory variables to the variability in the performance measure \(FP_i\) is determined as illustrated in equation (3):

\[
\sigma_{FP_i} = \sigma\left(FP_i \mid \alpha_0, \alpha_1, \ldots, \alpha_k\right) = \sqrt{\left(\hat{\alpha}_0 + \hat{\alpha}_1 x_{1i} + \ldots + \hat{\alpha}_k x_{ki}\right)^2 + \sum_{g=1}^{k} \sum_{h=1}^{k} \hat{\alpha}_g \hat{\alpha}_h x_{gi} x_{hi} + \sigma^2}, \tag{3}
\]

where \(\sigma_{\alpha_0}\) and \(\sigma_{\alpha_i}\) represent the variance of variate \(X_g\) and the covariance of variate \(X_g\) and \(X_h\), respectively. Hence, the variance of \(NFI\) as specified in equation (3) can be described as the sum of explained variance-covariance effects attributed to the model’s explanatory variables (\(\Omega\)) and unexplained variance due to an error term. Thus, equation (3) can be rewritten as:

\[
\sigma_{FP_i} = \Omega + \sigma_. \tag{4}
\]

Consequently, the coefficients of separate determination are computed

\[
\begin{bmatrix}
C_1 &=& \left(\hat{\alpha}_0^2 x_{1i} + \hat{\alpha}_1 \hat{\alpha}_2 x_{12} + \ldots + \hat{\alpha}_k \hat{\alpha}_k x_{1k}\right) / \sigma_{FP}, \\
C_2 &=& \left(\hat{\alpha}_2 \hat{\alpha}_1 x_{21} x_{21} + \hat{\alpha}_2^2 x_{22} x_{22} + \ldots + \hat{\alpha}_k \hat{\alpha}_k x_{2k} x_{2k}\right) / \sigma_{FP}, \\
&= &\vdots \ldots \vdots \\
C_k &=& \left(\hat{\alpha}_k \hat{\alpha}_1 x_{ki} x_{ki} + \hat{\alpha}_k \hat{\alpha}_2 x_{ki} x_{ki} + \ldots + \hat{\alpha}_k^2 x_{ki} x_{ki}\right) / \sigma_{FP},
\end{bmatrix} \tag{5}
\]

as:
Because any particular income component \( X_g \) (\( g=1, \ldots, k \)) may be negatively correlated with some or all of the other income components, it is possible that some of the \( C_g \) terms will be negative. This can occur when the value reflecting the sum of the correlations \( \sigma_{gh} \) (\( g \neq h \)) is negative and its absolute value is larger than \( \sigma_{gg} \).

The explained variation of the dependent variable \( NFI \) is described by the goodness-of-fit measure, \( R^2 \), which is equivalent to the following:

\[
R^2 = \sum_{j=1}^{k} C_j = \sum_j \sigma_{\hat{Y}Y}, \quad (6)
\]

where \( j \) represents the \( j \)th coefficient of separate determination. The unexplained variation in \( NFI \) is therefore equal to 1 \(- R^2 \).

Data

The data source for this analysis was the 1996 "Agricultural Resource Management Study" (ARMS) survey. The ARMS survey, a complex stratified national annual survey of farms, is jointly conducted by the USDA's Economic Research Service (ERS) and the National Agricultural Statistics Service (NASS). The survey collects data to measure the financial condition (farm income, expenses, assets, and debts) 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 certain number of farms that may be similar—referred to as a survey expansion factor.

Table 1. Definitions and Means of Variables Used in Weighted Least Squares Estimation Procedure

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definitions</th>
<th>Limited Resource Farms</th>
<th>Other Small Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operator Characteristic:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{AGE} )</td>
<td>Age of the farm operator (years)</td>
<td>60</td>
<td>54</td>
</tr>
<tr>
<td><strong>Farm Characteristics:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{DEBTAST} )</td>
<td>Debt-to-asset ratio</td>
<td>0.09</td>
<td>0.29</td>
</tr>
<tr>
<td>( \text{VALPROD} )</td>
<td>Total value of agricultural production ($)</td>
<td>15,660116,684</td>
<td></td>
</tr>
<tr>
<td>( \text{SOLE} )</td>
<td>Type of business organization (1 if farm is organized as sole proprietorship, 0 otherwise)</td>
<td>0.87</td>
<td>0.78</td>
</tr>
</tbody>
</table>
The expansion factor, in turn, is defined as the inverse of the probability of the surveyed farm being selected. In total, our study sample is comprised of 284 limited resource farms (representing a population of 220,263 U.S. farms) and 2,718 other small farms (representing a population of 555,390 U.S. farms).

Table 1 presents the definitions and corresponding means of the variables used in two separate regressions based on NFI and OLMI as dependent variables. When survey data are collected using a complex sample design, as in the ARMS, there is no simple analytical procedure for obtaining unbiased and design-consistent estimates of both parameters and variances. Because the probability of selecting a particular observation differs across farms in the
sample, using ordinary least squares instead of weighted least squares will produce biased parameter estimates. Further, the variance of survey statistics using standard statistical packages (such as SAS or SPSS) is inappropriate (Brick, Broene, James, and Severynse). Therefore, the replication approach employing a delete-a-group jackknife method is used as the variance estimator (Kott). A major advantage of using the replication approach with the ARMS is that survey weight adjustments, such as for post-stratification and nonresponse, can be reflected in the variance estimates.

Limited resource farms (LRFs) comprise 16% of small farms and 11% of all U.S. farms. Average acres owned and operated by limited resource farmers are 68 and 100 acres, respectively. The tenancy rate in this group is 12%. Many limited resource farms experience negative returns to farming.7 The average farmer is 60 years of age. The average value of agricultural products sold by limited resource farms is approximately $15,660, and they have a low debt-to-asset ratio (0.09). Limited resource farms are mostly beef operations, 87% of the farms are organized as sole proprietorships, and only 13% of limited resource farmers buy basic crop insurance. Finally, on average, limited resource farms have higher variable and fixed costs per dollar of output (Table 1) than other small farms.

7Although the value of agricultural production is positive, 1996 ARMS data show that 46% of limited resource farms reported negative net farm income.

Other small farms (OSFs) represent approximately 40% of small farms and approximately 28% of all farms in the U.S. In contrast to LRFs, operators of OSFs are younger and farm larger areas (341 acres). The average value of agricultural products sold by OSFs is approximately $117,000, and they have a debt-to-asset ratio of 0.29. Only 78% of the farms are organized as sole proprietorships, and 54% of this group of farm operators keep records on farm income and expenditures. About 35% of OSFs have basic crop insurance. Other small farms are more diversified than limited resource farms in that they have a mix of cash grains, other field crops, beef, and other livestock. Finally, on average, OSFs differ greatly in terms of their cost structure when compared with limited resource farms. OSFs have lower variable and fixed costs per dollar of output (about 50% lower) than their LRF counterparts (Table 1).

Results
Table 2 presents the weighted least squares estimates of factors hypothesized to affect profitability of limited resource farms (LRFs) and other small farms (OSFs) for the NFI and OLMI models. In the case of limited resource farms, the adjusted $R^2$'s (between 0.32 and 0.31) for the NFI and OLMI models indicate that the explanatory variables used in the weighted least squares regression explained 32% and 31% of the variation in LRF net farm income and operators' labor and management income, respectively. In contrast, a higher adjusted $R^2$ of 0.56 for the other small farms NFI model indicates that the explanatory variables used in the regression explained 56% of the variation in OSF net farm income. In general, the levels of explained variation observed in Table 2 are fairly typical when analyses are based on cross-sectional data (El-Osta and Johnson).

**Limited Resource Farms**

Several conclusions about LRFs emerge from the findings reported in Table 2. Results show a negative and significant relationship between the two measures of profitability (NFI and OLMI) and debt-to-asset ratio. A possible explanation is that most LRFs likely have a rate of return which is less than the cost of borrowing capital; hence, higher levels of debt-to-asset ratio reduce the level of profit. Our findings are consistent with those reported in other studies (Lins, Ellinger, and Lattz; Lazarus, Streeter, and Jofre-Giraudo; Kauffman and Tauer).

The age of the farm operator is an important factor that determines profitability of limited resource farms when defined as NFI, but not when defined as OLMI. The AGE variable has a negative and significant effect on net farm income. Haden and Johnson report a similar finding in their study of dairy farms in Tennessee. This result is consistent with the fact that young farmers have fewer assets, with a corresponding likelihood of lower profits. When farmers get older, however, the situation is often reversed—as evidenced by the significant positive relationship between AGESQ and net farm income. Another interpretation of this finding is that older farmers, having more experience, are better able to allocate resources where they are needed and can be fully utilized. Such action warrants an increase in returns to farmers' management abilities. This particular notion may be evident from the positive and significant relationship observed between AGESQ and OLMI (Table 2).

*This likely reflects the fact that farming experience builds farming-specific
human capital.

Controlling costs is one of the components that determines farms’ profitability and success (Mishra, El-Osta, and Johnson). Results show a negative and significant relationship between ratio of variable costs to total value of agricultural production \((VCOPVP)\) and ratio of fixed costs to total value of agricultural production \((FCOPVP)\) when farm profitability is measured in both \(NFI\) and \(OLMI\) terms for limited resource farms. Our findings indicate that farms which have controlled their cash operating and fixed expenses are more profitable. These results are in agreement with the conclusions of other investigators (Kauffman and Tauer; Haden and Johnson; Korth; Luckham; Sonka, Hornbaker, and Hudson; Warren and Burritt; Ali and Johnson; and Wood, Johnson, and Ali).

Another factor that affects farm profitability is soil productivity. As shown in Table 2, soil productivity \((MEANPI)\) has a positive sign and is statistically significant in the case where profitability of limited resource farms is measured by net farm income. With higher soil productivity, one would expect short-run profitability to be higher for any given level of input use. These results are consistent with the findings of Garcia, Sonka, and Yoo.

An additional factor that determines farm profitability is risk management. Crop insurance has been one of the tools used by farmers to manage risk. Based on our results, limited resource farmers who bought basic crop insurance \((CROPINS)\) increased farm profitability, as measured by operators’ labor and management income \((OLMI)\). A heavy subsidy factor in crop insurance may contribute to this positive relationship.

**Other Small Farms**

Results of the two models \((NFI\) and \(OLMI)\) based on other small farms (OSFs) are quite different than those obtained in the case of limited resource farms. Age and controlling variable costs play an important role in profitability of other small farms, when either of the profitability measures \((NFI\) and \(OLMI)\) is considered. The sign on the value of agricultural production \((VALPROD)\) is positive and statistically significant in both cases, possibly indicating economies of size. This result is in agreement with the findings of Burton and Abderrazak; Matulich; Haden and Johnson; and El-Osta and Johnson.

The \(SOLE\) variable was used to indicate the type of
business organization of the farm. Under both measures of profitability, SOLE has a positive and significant effect on the profitability of other small farms. Results show that farms organized as sole proprietorships are more profitable than farms employing other forms of legal organization (as supported by the findings of Kauffman and Tauer). One explanation for this is that farms controlled by one individual are in a better position to manage resources efficiently. Another reason is that under sole proprietorship, there is no dilution of earnings--i.e., earnings do not need to be divided among other partners (see Kauffman and Tauer). Yet another potential reason for the higher profitability of sole proprietorships (as noted by a reviewer) is that other forms of business organization allow more expenses to be deducted, which, in turn, results in lower profits. For instance, certain corporations are able to deduct salaries to corporate members who are working on the farm, and such corporations also may deduct insurance premiums.

Farm diversification by other small farms, as measured by the entropy index (DIVERSIF), has a positive and significant effect on both measures of profitability. Results suggest that farmers who diversify their production activities are likely to experience increased net farm income and returns to operators' labor and management income. (As noted earlier, since this study is based on cross-sectional data, significance of this variable should be interpreted with caution.)

Finally, other small farms can reduce risk in income by purchasing crop insurance. The coefficient on CROPINS shows a positive and statistically significant effect on both NFI and OLMI, indicating that farm operators who bought basic crop insurance observed higher earnings than farm operators who did not buy crop insurance.

**Variability Decomposition Results**

The regression results are used to assess how variability in profitability is affected by each of the explanatory variables used in the weighted least squares procedure (Table 2). Such an assessment is accomplished by employing the method of coefficients of separate determination where the sum of these coefficients for a particular regression model equals the goodness-of-fit measure, commonly referred to as $R^2$ (Burt and Finely; Langemeier, Schroeder, and Mintert).

Table 3 presents the coefficients of separate determination
for factors affecting both net farm income (NFI) and operators' labor and management income (OLMI) for limited resource and other small farms. The ratio of variable costs to total value of agricultural production (VCOPVP) is the most important variable in explaining the variability in net farm income (NFI) and operators' labor and management income (OLMI) for limited resource farms. This is based on values of coefficients of separate determination of 0.2219 and 0.2210, respectively, which are the highest among all variables (Table 3).

In contrast, farm diversification (DIVERSIF) is the most important variable in explaining the variability in NFI for other small farms. However, variability in the ratio of variable costs to total value of agricultural production (VCOPVP), and value of agricultural production (VALPROD) are also important (Table 3). When measuring profitability of other small farms in terms of OLMI, the ratio of variable costs to total value of agricultural production (VCOPVP) is found to contribute the most toward explaining the variability, based on a value of coefficients of separate determination of 0.1405 (Table 3).

Summary and Conclusions

Given the renewed interest in small farms, this study focuses on the determinants of the profitability of two groups of small farms—limited resource and other small farms. Limited resource farms and other small farms are different in terms of the age of the farm operator, enterprise selection, costs of production, degree of farm diversification, debt-to-asset ratio, and value of production.

Table 3. Coefficients of Separate Determination for Factors Affecting NFI and OLMI for

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<tr>
<td></td>
<td>NFI</td>
<td>OLMI</td>
</tr>
<tr>
<td>AGE</td>
<td>0.1061</td>
<td>0.1155</td>
</tr>
<tr>
<td>AGESQ</td>
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Data from the USDA's 1996 "Agricultural Resource Management Study" (ARMS) survey were used in a multivariate analysis framework to determine factors associated with profitability, as measured by net farm income (NFI) and operators' labor and management income (OLMI). Based on the NFI measure, the profitability of limited resource farms (LRFs) is positively correlated with soil productivity and negatively correlated with costs (both variable and fixed) of production, farm's debt-to-asset ratio, and the age of the operator. Based on the OLMI measure, results indicate that lower debt-to-asset ratio and use of crop insurance increase profitability of limited resource farms. Further, higher ratios of variable and fixed costs to total value of agricultural production (VCOPVP and FCOPVP, respectively) lower the profitability of limited resource farms.

In the case of other small farms (OSFs), farm size, farm diversification, use of crop insurance, controlling variable costs of production, and organizing the farm as a sole proprietorship all have a positive impact on farm profitability, regardless of whether profitability is measured by NFI or by OLMI. Further, our findings show a negative and significant relationship between operator's age and the profitability of other small farms when profitability is measured by operators' labor and management income (OLMI).

An examination of the explained variation in the net farm income and operators' labor and management income of limited resource farms using the method of coefficients of separate determination identified the ratio of variable costs to total value of agricultural production as the factor contributing the most to variability.

In the case of other small farms, farm diversification and
the ratio of variable costs to total value of agricultural production contributed the most to the variability in net farm and operators' labor and management incomes. These results indicate that controlling variable and fixed costs—in particular the variable costs—can help farms to increase their profitability.

This study found that for limited resource and other small farms to become more profitable, controlling their variable and fixed costs is more effective than other measures considered. Limited resource and other small farm operators may also benefit if crop insurance-type programs are extended to livestock and other specialty crops. The likelihood of success for limited resource and other small farms could be enhanced by policy makers in providing relatively inexpensive credit to low-equity and beginning farmers. Our findings suggest that lower debt-to-asset ratios could increase the profitability of limited resource farms. One strategy that could be used by beginning and limited resource farmers to increase farm profitability is to lease farm land and farm equipment, which would minimize the need for capital financing. Policy makers could design policies aimed at encouraging lenders and owners of capital inputs to make leasing more accessible to limited resource farmers, thereby increasing the likelihood of financial success for this group of farmers.

References


Amer. J. Agr. Econ. 50(1968): 734-44.


Garcia, P., S. T. Sonka, and M. S. Yoo. "Farm Size, Tenure, and Economic Efficiency in a


Hoffman, R. "Size and Profitability: It's Better to Be Good than Big, but You Can't Beat Good and Big." Farm J. (Mid-March 1996):23.


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