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Examining Farm Financial Management: How Do Small US Farms Meet Their Agricultural Expenses?

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Abstract: Small farms in the US have significant challenges in financial management. This study examines how small farmers undertake farm financial management to meet their agricultural and farm-related spending and expenses. Using primary survey data from Tennessee, the study investigates the factors influencing the extent of use of five financing sources to meet the spending and expenses: cash/fund directly generated from the sale of agricultural products, farmer's past savings, farm household's off-farm income, income/incentives from government payments, and external loans. Using negative binomial regression estimation of generalized linear models, findings suggest that the decision on the use of financing sources is significantly influenced in general by age, education, income and land acreage holdings, off-farm work, and risk factors related to farmer or farm household. However, the associated factors and their effects on the extent of use are different depending on the financing source.

Keywords: farm financial management; farm management; small farms; survival risk; savings; debt; off-farm incomes



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1. Introduction

Agriculture continues to be the key economic activity and engages a vast number of households in rural areas. Worldwide, there are about 450 million households that depend on agriculture for their major source of income. In the United States, farm production is a billion-dollar industry (Areguin and Stewart 2021), where with around 897 million acres of land under farms (ERS, USDA 2022). In 2019, the output of US farms contributed 136.1 billion USD while the total contribution from agriculture, food, and related industries was estimated around 1.109 trillion USD (ERS, USDA 2022). However, approximately 89% of the farms in the United States are small¹ family farms, those who make annual gross farm incomes of 350,000 USD or less (ERS, USDA 2022). US small farms contribute meaningfully to a diverse and attractive rural landscape, local economics, the country's food resource, and stronger rural communities (Hoppe et al. 2010; Khanal and Mishra 2014). Small farms in the United States are the main producers of beef, grains/soybeans, poultry, and hay, as well as minor providers of fruits, vegetables, and dairy products (Hoppe et al. 2010). Small farms also contribute significantly to the export market, creating a positive agricultural trade balance. The above information shows how important these small farms are to the United States economy. As important as they are, small farms are faced with the problem of limited supply of land and capital, low productivity, increasing input prices, natural disasters (drought, flood), limited managerial ability, unfavorable government policies, limited skilled labor, and maintaining a sufficient level of finance. These challenges may lead to a lack of ability to use improved technology, innovative and advanced managerial practices, intensive farming, and the use of most cost-effective enterprise mixtures (Dercon 2008, 2009; Dercon and Christiaensen 2011; Townsend 1994).

Finance and fund management is one of the most vital factors of production to start up and continue a farm business because most businesses require a higher level of capital than

the business owner has at their disposal; the farmer has to be able to meet up with cash obligations. Finance in agriculture is important not only to meet long-term agricultural needs but also to meet short-term needs such as to purchase new and high-yield seed variety and input, hire labor, adopt new technology, improve efficiency, adopt better marketing strategies, and cope with different levels of risk. Farming and agriculture activities are subjected to various risks. In certain cases, the high risk and uncertainty in agriculture limit the effectiveness of financial instruments. However, the adoption of multiple risk management tools (Velandia et al. 2009; Adhikari and Khanal 2021), a variety of crop or enterprise insurance mechanisms (Goodwin 1993; Sherrick et al. 2004; Goodwin and Smith 2013; Janowicz-Lomott and Łyskawa 2014; Sall and Tronstad 2021), and multiple funding modalities and financial structures (Havemann et al. 2020) have been discussed in the literature to mitigate risks in agriculture. With risk management tools, farmers may be able to benefit from external credit or a loan to some level.

Farms rely on their own income sources or formal and informal loans to meet their expenses. A formal source of loan basically refers to borrowing from formal financial institutions such as banks and credit unions and similar nonfinancial institutions but governed, regulated, and supervised by the state law. Some frequently used formal sources of finance include commercial banks, Farm Credit System, Farm Service Agency (FSA), State Agricultural Development Programs, and Community-Supported Agriculture (CSA). Informal sources on the other hand constitute borrowing that occurs outside the formal financial sector. It is a form of borrowing that occurs with contracts or agreements without referencing the legal system to exchange cash or funds with the expectation of being paid back at a future date (Schreiner 2001). Some informal sources of finance include personal savings and borrowing from friends, families, and other individuals, especially in rural areas. These two sources of finance can be utilized either separately or simultaneously² (Banerjee and Duflo 2007).

Small farmers face some challenges and constraints while trying to access credit. Being credit-constrained may exist in two forms; it can involve having access to partial credit which is not sufficient or no access to credit at all when credit is desired (Khanal and Omobitan 2020). Credit constraints have a direct and indirect impact on farm productivity and efficiency. Directly, credit constraints can affect the farmer's purchasing power to buy inputs and fund operating expenditures in the short run, as well as farm-related investment decisions in the long run. Indirectly, they can affect the risk behaviors of farmers, which also influence the farmer's technology choice and adoption (Guirkingner and Boucher 2008; Eswaran and Kotwal 1990). Small farms also face some restrictions to the formal source of finance because of the small size of their credit operations, inadequate assets, and institutional difficulties, which limit their capability to collateralize. In such case, small farmers, mostly in rural areas, have to also depend on lenders in the informal market. Turvey (2017) presented historical perspectives of agricultural financing and farm credit systems in the US and discussed the limitations of rural financial markets, binding liquidity constraints, credit access, and collateral difficulties impeding farm profitability and investment. Specific to the empirical findings on the adverse effect of credit constraints, studies have reported or found limited credit, credit-related factors, and constraints significantly important in the US farm sector (Briggeman et al. 2009; Chaddad et al. 2005; Hartarska and Nadolnyak 2012; Sabasi et al. 2021), adversely affecting farm incomes, outputs, and rural economic growth (Briggeman et al. 2009; Nadolnyak et al. 2017; Hartarska et al. 2015). Specific to credit constraints and small US farm performance, Khanal and Omobitan (2020) estimated around 32,000 to 39,000 USD lower gross farm incomes attributable to constrained or deficient borrowing.

Finding an appropriate source of capital is challenging for small farms. Various factors could influence these decisions. High interest rate and collateral unavailability may restrict small farmers to use their self-generated or earned money. The self-generated or earned money is usually not sufficient for small farms for farming operations. On the other hand, debt financing or outsider loans are risky and challenging, and one's risk attitude-related

factors could play a role. Age and education level of farmers serve as indicators for the degree of risk aversion (Niu 2010). In some findings, older farmers with a lower education level are predicted to have a higher risk aversion compared to their younger and more educated counterparts (Rosen et al. 2003). On the other hand, one can also expect that older farmers may take higher risk if former credits are already paid back. Similarly, lower education may impede the capacity to accurately assess the risk of investments. The legal status of the firm is also a basis for lenders to decide about a farmer's credit risk; contrary to the limited liability of corporate firms, family farms are typically organized as sole proprietorships and take up full liability. When farmers are assured of the long-term use of their land, they have greater motivation to borrow and invest (Brasselle et al. 2002). Small farmers rely to some degree on external loans to finance their farm activities. However, the funding level and the costs vary greatly among small farmers (Barry and Robinson 2001).

The majority of small farmers also primarily rely on off-farm work to enhance household income, as well as to repay their debts, because farm income alone is not enough for many small farmers to pay off their debt and agricultural expenses. Small farms adopt multiple risk management strategies on and off the farm (Adhikari and Khanal 2021). Most of the farm household's off-farm income comes from off-farm work (80%), while the remainder (20%) may come from other off-farm sources, such as interest on bank accounts, stock dividends, and revenues from rental property (Briggeman et al. 2009). It is increasingly common for farm operators and their spouses to work off-farm in the US; Brown and Weber (2013), on the basis of nation-wide data from the USDA, found that at least one family member of 91% of the farm households worked in an off-farm job. Consequently, off-farm employment is the major source of income for a vast number of farm households. However, the extent of off-farm work and the degree of the farm household's reliance on it depends on size, type of enterprise, and age of the operator. Off-farm income is a source of supplemental income for agricultural spending and debt repayment for most farm families (Zech and Pederson 2003; Stam et al. 2003); higher income leads to higher repayment capacity (Featherstone et al. 2006; Briggeman et al. 2009).

Subjected to all these challenges, it is interesting to analyze the financial choices made by small farmers to meet their agricultural spending and expenses. The research on farmers' financing choice decisions can help to investigate a set of research questions related to factors influencing the extent of the use of these financing means among small farms. This study investigates the farm financial management of small farms, which are mostly capital-constrained. We particularly examine how small farms meet their agricultural spending and expenses and assess factors influencing decision choice on the extent of these different kinds of financing sources. To investigate the research question, we conducted a primary survey among small farms and analyzed data using a generalized linear model with negative binomial distribution, appropriate for the nature of our data.

2. Data and Methodology

2.1. Sampling and Data Collection

Primary data were collected from Tennessee farmers in 2017–2018 through a structured questionnaire which was administered via e-mails. Specifically, a survey link which accommodated the designed questionnaire was sent to farmers through e-mails. An electronic (e-mail) survey method was chosen because it is considered a cost-effective and quick method to administer. To achieve a high response rate from electronic mail, reminders were sent to nonrespondents 3 weeks after the survey was sent via e-mail, and a second reminder was sent 2 weeks after the first reminder. This was continued until a reasonable number of responses were obtained. This is in line with the study of Dillman (1991) showing that repeated contact with respondents often increases response rate.

Contact details of farmers were collected using a database maintained by the Pick Tennessee Products organization. The Pick Tennessee Products database has different categories of producers ranging from fruits, vegetables, herbs, and mushrooms to honey, meats, poultry, eggs, dairy, and certified organic producers. The database includes east,

west, and middle regions, which are also further categorized on the basis of counties in Tennessee. The total number of farmers' e-mail addresses and contacts that were extracted using a stratified random sampling method based on counties from different categories of produce was approximately 720. The questionnaire was pretested to evaluate consistency and clarity. With continuous reminders sent to the farmers, we received a total of 104 responses. Excluding four surveys that indicated gross sales of more than 350,000 USD (threshold for small farms), we used 100 responses specific to small farmers.

2.2. Conceptual and Empirical Model

Farmers need to meet their agricultural spending and expenses in at least two aspects: day-to-day expenses requiring capital with liquidity and intermediate- to long-term spending toward investments or agricultural-related spending on expansion. However, small farms are subjected to greater challenges on how to meet these required expenses to survive and continue the farm operations. In that, the choice of the financing methods, mainly within self-generated fund types or through external credit and loans, is important. This choice of source and the extent of use of this source (how much of total spending and expenses is met by this source) is assumed to be affected by demographics, socioeconomic settings, and related factors associated with farmer and farm households. In conceptual generic form, with y^k representing the extent of financing using source k , we assume that factors such as age, education, asset holdings, risk-related factors, gender, household size, and off-farm work represented as $X_1, X_2, X_3, X_4, \dots, X_n$ can affect this financing choice.

$$y^k = f(X_1, X_2, X_3, X_4, \dots, X_n). \quad (1)$$

We assume that farmer- and farm-related factors could have different magnitudes and directional relationships to different sources of financing. Conceptually, the extent of the use of a particular source and the importance of that source are assumed to be different depending on farm or farmer's attributes captured through multiple variables. For example, to meet expenses through external credit and loans, farms need loans, depending on whether the farmer has adequate access and availability. Any difficulty due to reasons such as complicated procedures and paperwork, problematic collateral requirements, lack of institutions providing loans in rural area, lack of established line of credit, no loans provided due to uncertainty in agriculture, and no information about where to get loans could hamper the adequate access to loans at the required or desired level. We define this multifaceted aspect as an indicator of credit constraint (described in detail in Section 3.2) and assume a negative association of this with credit use. For credit-constrained farms, there could be a higher likelihood of using other sources such as savings, off-farm income, and income generated from agricultural product sales, assuming a positive association. We also assume a significant relationship of operator's age and education factors with the extent of use of different financing sources. For example, relatively younger farmers may have less savings to start with but require more external credit and loans to begin investment. We expect a positive relationship of savings with age. On the other hand, younger farmers may not have an established line of credit and may be perceived as risky borrowers by lenders because of less experience or a lack of success history, which leads to low loan receipt and, hence, low or no external credit to meet agricultural expenses. One can also assume that the older farmers who might have paid off previous loans have ability to take higher risks in terms of external debt. Together, we expect an ambiguous relationship of external credit use with age. Education may enable better financial management and higher financial literacy on the importance of savings, as well as a chance of earning higher off-farm incomes. Lower education may also mean less ability in assessing the risks of investments, leading to higher risks including risk of debt. With these prospects, we assume that education level significantly affects the extent of use of different source of financing and has effects in different directions depending on the source. However, the relationship and direction of some variables may not be conceptually clear. In that case, for a given specific sample of small farms, empirical examination offers the better answer. Therefore,

while we explain conceptual linkages of some variables using a conceptual model, we comprehensively discuss the significant findings and link them with previous empirical studies in the result section. Next, we present the empirical econometric model to estimate the associated relationship on our data.

We estimate econometric models with dependent variables representing the extent of different³ k number of financing sources or methods used by small farms, represented in the following equation form:

$$y_i^k = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \dots + \beta_n X_{ni} + \varepsilon_i, \quad (2)$$

where y_i^k represents farmer i 's financing mode k . Different modes of financing of farmer i include the modes such as financing through credit/loans, income from government payments, income from off-farm work, past savings, and agricultural (crop/livestock) sales, which the farmer uses to meet agricultural spending. $X_{1i}, X_{2i}, X_{3i}, X_{4i}, \dots, X_{ni}$ represent different explanatory variables influencing this decision of the extent of use of this financing mode. $\beta_1, \beta_2, \beta_3, \dots, \beta_n$ represent coefficients of respective independent variables to represent the relationship of independent variables with the dependent variable; ε_i represents the error terms. Our estimation consists of k different equations to represent k number of financing methods chosen by farmer i .

It should be noted that the extent of use of a financing method in our questionnaire⁴ (dataset) was in the form of categorical whole integers. Therefore, to estimate models appropriately, we used a class of generalized linear model (GLM) specifying a negative binomial family with Poisson distribution of error terms to account for the count nature of the dependent variable. In the negative binomial regression, the dependent variable is an observed count that follows the negative binomial distribution to account for the nonzero integers in count form: 5%, 10%, 25%, 30%, 35%, 45%, 50%, and so on. Negative binomial regression is a generalization of Poisson regression which relaxes the restrictive (and quite impractical) assumption of Poisson that the variance is equivalent to the mean.

3. Results and Discussion

Table 1 presents summary statistics of the variables used in this study. We present the variable description, mean, and standard deviation of the variables. The explanatory variables used in this study are independent variables used in different regression models, which represent socioeconomic, demographic, and farm-related variables of small farmers in Tennessee. The age variable shows that 5% of our sampled farmers were aged below 35 years, 46% were aged between 36 and 54 years, 25% were aged between 55 and 64 years, and 22% were aged more than 65 years. Regarding the education level of sampled farmers, 16% completed high school education, 6% completed college, and 22% completed graduate school or higher. Our dummy variables of gender (male) and marital status (married) show that 68% of sampled farmers were male, and 92% were married. Our sampled farmers had average household incomes of around 55,930 USD with an average family size of three members. Gross farm incomes of sampled farms in the data averaged 43,900 USD. Furthermore, looking at the distribution of gross farm income in our data, 92% of sampled households had a gross farm income below 100,000 USD, indicating that Tennessee is dominated by very small farms within the category of small farms. The average gross farm income of our sample is comparable with recent US Census data of Tennessee ([Census of Agriculture 2017](#)), which showed that the largest portion of farmers were very small farmers; 65,701 farm operations out of a total 69,983 farm operations in Tennessee (93.8%) had a gross farm income below 100,000 USD ([Census of Agriculture 2017](#)). Lastly, Table 1 also shows that around 84% of sampled farms use smartphones with internet access, and around 85% expected to continue farming in the next 5 or 10 years from now.

Table 1. Summary statistics of variables used in the study.

Variables	Description of Variables	Mean	Std Dev.
Panel A: Explanatory variables			
Cred_cons	Whether farmer is credit constrained (=1 if constrained)	0.58	0.5
Age below 35	Age of principal operator below 35 (=1 if age below 35)	0.05	0.22
Age 36 to 54	Age of principal operator between 36 to 54 (=1 if age between 36 to 54)	0.46	0.5
Age 55 to 64	Age of principal operator between 55 to 64 (=1 if age between 55 to 64)	0.27	0.44
Age 65 or above	Age of principal operator 65 and above (=1 if age 65 and above)		
High school	Education level of principal operator is high school (=1 if high school)	0.16	0.37
College	Education level of principal operator is college (=1 if college education)	0.6	0.49
Grad.Degree	Education level of principal operator has graduate degree (=1 if graduate)		
Male	Gender of principal operator (=1 if male)	0.68	0.47
Married	Marital status of principal operator (=1 if married)	0.92	0.31
Log hhinc	Gross annual household income (in US dollars, in log)	11.03	1.07
hhsiz	Number of family members	2.69	1.49
Offfarm_hrs	Number of off-farm hours per week by the operator (farmer)	16.33	20.96
Smart phone	Use of smartphone with internet access (=1 if smartphone use in farm activities)	0.84	0.37
Continue plan	Expected to continue farming in 5 to 10 years (=1 if continue plan)	0.85	0.36
Diverse_score	Agricultural enterprises diversification (score)	2	1.29
Risk prcp	Farming operation's level of risk perception (range: 1 to 5)	3.1	1.18
Risk con	How much concern about risks in agricultural production, management, and marketing (range: 1 to 5)	2.7	1.10
Panel B: Dependent variables			
Fund_sale	Extent of use of fund generated through sales of agricultural products to meet farm expenses (percentage)	48.15	31.77
Fund_save	Extent of use of past savings to meet farm expenses (percentage)	11.1	18.33
offfarminc	Extent of use of off-farm income to meet farm expenses (percentage)	25.75	29.53
govpayinc	Extent of use of money from government incentives/payments to meet farm expenses (percentage)	2.55	4.79
Fund_loan	Extent of use of credit/loans to meet farm expenses (percentage)	7.05	17.47
Fund_other	Extent of use of other sources (besides listed above) to meet farm expenses (percentage)	4.5	13.66
Number of observations		100	

3.1. Enterprise Diversity, Off-Farm Work, and Perceived Risks of Small Farms

On-farm enterprise diversification is considered as one of the risk management strategies for farmers. We computed enterprise diversity scores of our sampled households. The score indicates the number of enterprises adopted by small farms. A higher diversification score implies higher agricultural enterprise diversification. The diversity score among sampled farmers averaged 2 and ranged from 0 to 8, indicating that small farmers adopted two agricultural enterprises on an average, but some farms adopted up to eight different agricultural enterprises. Another way of income diversification, off-farm work, is considered as a strong risk management strategy for small farms. We measured off-farm works of the small farm operator in terms of the number of hours per week. We found that the farm operators of small farm households worked approximately 17 h per week off the farm, on average. This is nearly a half-time formal job, as 40 h per week of work is considered a full-time job.

Small farmers continue to face higher survival risk in the US. We measured this aspect in this study using indicator variables of risk perception and risk concern, namely, perceived survival risk of the farm operation and the concern level of this risk on production, management, and marketing. On a scale of very high (5) to very low (1) and no (0), we found an average score of 3.1, indicating a moderate level of risk of survival perceived by small farmers. The risk concern variable captures the level of concern about the production and marketing risks on the scale from very high concerned (5) to no concern (0). Additionally,

the risk concern variable average of 2.7 indicated that small farmers were moderately concerned about the risks in their production and marketing (Table 1).

3.2. Credit Constraints among Small Farms

The credit constraint variable indicates the small farm's limited capacity to capital markets. We measured the credit constraint variable as a dummy variable, where 1 implies being credit-constrained and 0 implies the opposite. In this study, our definition of credit constraint was based on the multifaceted comprehensive definition, following [Khanal and Omobitan \(2020\)](#). A small farmer can be credit-constrained if the farmer has difficulty in getting agriculture-related loans due to any of the following reasons: (a) high interest rate, (b) complicated procedures and paperwork, (c) problematic collateral requirements, (d) lack of institutions providing loan in rural area, (e) lack of established line of credit, (f) no loans provided due to uncertainty in agriculture, and (g) no information about where to get loans. We found that more than half of our sampled small farms (approximately 59%) were credit-constrained (Table 1).

3.3. Sources and Uses of Funds among Small Farms in the US

Figure 1 and Panel B of Table 1 present the different sources of funds used by small farms in the US to meet their agricultural spending and expenses. To meet their agricultural spending and expenses, small farmers use sales from their agricultural produce (fund_sale), past savings (fund_save), off-farm income (offfarminc), income from government payments and incentives (govpayinc), and external loan and credits (fund_loan). Figure 1 shows the distribution of sources used to meet farm expenses by small farms. For example, around 30% of sampled farmers (the highest) obtained more than 75% of their funds meeting farm expenses from the sales of their agricultural products, followed by 8% of sampled farms financing 75% or more through off-farm income and past savings. Some other sources of financing for small farms for agricultural expenses came from loans, government payment/incentives, and other sources (Figure 1).

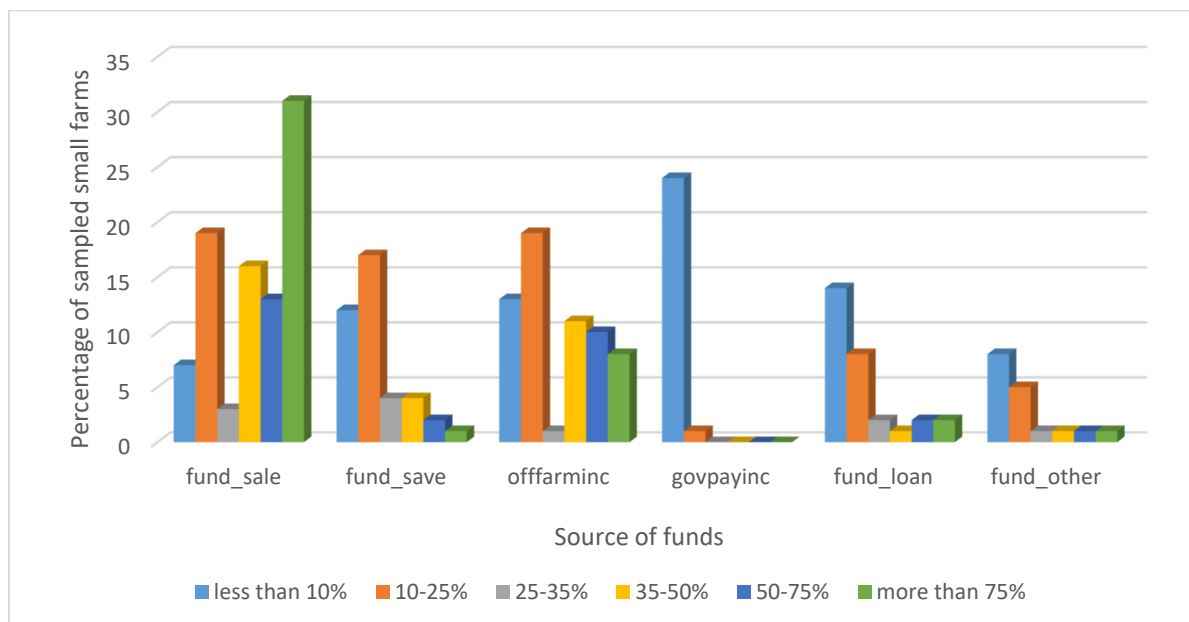


Figure 1. Different sources of financing and the extent of use to meet agricultural expenses by small farmers in Tennessee.

Panel B of Table 1 shows the description of the extent of fund sources used by small farms. The mean value of 48.15 on fund_sale indicates that, on an average, 48% of the farm expenses among the sampled farmers were met through the money generated from the

sales of their agricultural products. The mean value of 11.1 on fund_save indicates that 11% of the farm expenses among the sampled farmers were met through their past savings. Interestingly, Table 1 also shows that around 26%, 3%, and 7% of the farm expenses among the sampled farmers were met through their off-farm income, income from government payment/incentives, and external credit/loans, respectively.

3.4. Factors Influencing the Extent of Use of Different Financing Sources

We examined the factors influencing the use and extent of financing sources using four regression equations, as presented in Table 2. Individual regression models were fit for each source using a generalized linear model with negative binomial specification. In particular, we present results of the model estimation for extent of use of “agricultural product sale” (fund_sale), “past savings” (fund_save), “off-farm incomes” (offfarminc), “income from government payments/incentives” (govpayinc), and “credit and loans” (fund_loan) through four equations in Table 2. The dependent variable in each equation (model) was a nonzero integer in count form: 5%, 10%, 25%, 30%, 35%, 45%, 50%, and so on.

Table 2. Factors influencing the extent of various financing sources used to finance farm expenses (dependent variables: extent of use (%) fund use from the indicated source).

Variables	Agricultural Product Sales (fund_sale)		Past Savings (fund_save)		Off-Farm Income (offfarminc)		Government-Paid Income/Incentive (govpayinc)		Credit/Loan (fund_loan)	
	(I)		(II)		(III)		(IV)		(V)	
	Coef.	t-Score	Coef.	t-Score	Coef.	t-Score	Coef.	t-Score	Coef.	t-Score
Constant	5.425 **	3.28	2.348	1.04	−1.826	−0.88	−11.518	−0.01	−10.702	−0.01
Credit constraint	−0.176	−0.63	−0.255	−0.60	0.084	0.25	−2.717 ***	−4.24	−1.779 ***	−3.06
Age below35	−1.230 *	−1.68	−3.322 ***	−3.44	1.015	1.28	−0.677	−0.58	−2.038 *	−1.80
Age 36 to 54	0.134	0.29	−0.642	−1.28	0.189	0.39	1.520 **	2.15	2.272 ***	3.27
Age 55 to 64	−0.414	−0.87	0.007	0.01	0.015	0.03	3.561 ***	4.18	2.967 ***	3.48
Highschool education	−0.635	−1.35	1.977 ***	3.12	−0.034	−0.07	0.481	0.73	−0.483	−0.68
College education	−0.005	−0.01	0.727 *	1.67	0.117	0.30	1.118 **	2.19	1.541 ***	2.69
Operator's gender = male	0.397	1.21	0.852 *	1.92	−0.264	−0.67	−1.369 **	−2.26	−1.154 **	−2.39
Operator is married	−0.424	−0.83	−0.754	−1.31	1.864 ***	3.06	−2.270 ***	−3.42	−1.781 **	−2.14
Farm household income (in log)	−0.002	−0.02	−0.327 *	−1.84	0.174	1.19	−0.199	−1.64	−0.628 *	−1.64
Household size	−0.199 *	−1.84	−0.167	−1.28	0.165	1.53	0.044	0.31	−0.112	−0.83
Operator or spouse's off-farm hours	−0.011	−1.49	−0.036 ***	−3.36			−0.039 ***	−3.47	−0.003	−0.28
Land acreage holdings					−0.005 ***	−3.15				
Smartphone with internet	−0.201	−0.54	1.178 ***	2.68	−0.094	−0.24	0.490	0.82	1.755 ***	2.67
Continuation plan	−0.251	−0.46	−0.237	−0.34	1.919 ***	3.12	17.221	0.02	16.951	0.02
Enterprise diversity score	0.088	0.64	0.952 ***	4.65	−0.016	−0.11	0.917 ***	3.91	0.088	0.54
Perceived survival risk	−0.033	−0.23	0.544 ***	2.55	−0.450 **	−1.98	0.009	0.03	−0.539 **	−1.96
Risk concern level	−0.063	−0.38	−0.045	−0.17	0.255	0.94	−0.591 *	−1.76	1.019	1.08
Log likelihood	−348.11		−219.93		−285.51		−125.499		−162.457	
AIC	10.142		6.58		8.403		3.958		4.985	
Number of observations	100		100		100		100		100	

***, **, and * indicate 1%, 5%, and 10% levels of significance; models were estimated using generalized linear model regression with negative binomial specification and log link.

The first column of Table 2 shows the results of fund_sale equation. Factors indicating age and household size were found to be statistically significant, both at the 10% level. A negative effect of the variable younger age on the fund_sale indicates that the younger farmers relatively met a lower percentage of agricultural spending and expenses through money generated from agricultural sales. One reason could be associated with the possible lower sales of younger farmers, which is in line with findings from [Haden and Johnson \(1989\)](#) in the case of dairy farmers in Tennessee. Another plausible reason is that young farmers may spend part of the money from agricultural sales to pay for external credits that are likely in early stages of the business and initial investment, which limits their use of this money to meet spending on agriculture. Another variable, household size, had a significantly negative effect on the extent of financing through fund_sale. One plausible explanation for this could be from the higher household needs and obligations that come from a higher household size. Small farmers with a large household size may spend a higher portion of their income accrued from sales toward other household expenses than

the farm expenses, e.g., to meet food and everyday supplies, utilities, rent, or education and recreation.

The second column of Table 2 presents results of our second equation, *fund_save*. The results show that factors such as age, education, household income, off-farm hours, smartphone with internet access, diversity score, and risk perception significantly influenced the use of savings. In the past, several studies have examined factors that influence savings on households and farm households. In the literature, factors such as education, age, family size, social group membership, income, occupation, gender, marital status, credit access, dependency ratio, and high costs of transport were discussed as significant factors in savings decisions (Lahiri 1989; Kibet et al. 2009; Akpan et al. 2011; Swasdpeera and Pandey 2012). Consistent with past findings, our results also suggest some of these factors to be statistically significant. Our negative coefficient for age below 35 on savings may indicate that younger farmers are less likely to save and, therefore, less likely to utilize savings as a source. Perhaps younger farmers need to invest more, which limits their savings, as they typically represent the earlier stages of business requiring initial investment. Gedela (2012), in his study on determinants of saving behavior in rural households, found a positive correlation between the age of the household head and savings, where an increase in age resulted in an increase in savings up to some age. Moreover, the likelihood of savings and the likelihood of using saving funds to finance may not necessarily be same. However, one can expect high correlation between these two. Our specific results suggest that the likelihood of higher savings use was lower for relatively younger farmers below 35 years.

The education variable was found to have a strong positive relationship on the extent of financing through past savings. Higher level of education probably helps a better financial management in general and, thus, better use of different sources or combinations, including the importance of savings. This is consistent with the findings of Teshome et al. (2014), who found that education has a positive effect on household savings. Our findings regarding the gender variable on savings suggest that male-headed households are likely to use savings to meet farm expenses. The effect of gender on savings has been well documented in the literature. A set of studies found that women are more conservative in their investment than men, and that women care more about income smoothing for the future. Our positive relationship of male gender with the extent of financing through savings may indicate this behavior. Female-headed households may value future income smoothing more and be hesitant to use past savings to meet current farm expenses. Our results also suggest that the household income has a negative effect on savings use. Similarly, the negative relationship of off-farm hours and savings use implies that higher off-farm hours reduce the extent of financing through past savings. Small farms with higher off-farm hours could generate higher cash and wage incomes and may be able to finance their needs through current income. Nehring et al. (2005) suggested that small farmers adopt a strategy to increase household income through involvement in more off-farm related activities. However, an increase in income through an increase in the number of off-farm hours may also lead to increased household consumption patterns or overconsumption, which may reduce money available for savings.

The positive effect of smartphone with internet access on savings may be associated with the farmers' higher financial literacy and knowledge of the importance of savings for future (Tadesse and Bahiigwa 2015). Moreover, the effect of farmers using smartphones with internet access on farming could be an indicator of early technology adopters or those valuing quick and efficient exchange of farming-related information. Another interesting variable, diversification, had a significantly positive effect on the use (extent of use) of savings. Enterprise diversification (higher number of crop/livestock enterprises adopted in the farm) helps in mitigating the effects of crop failures (Dercon and Krishnan 1996; Barrett et al. 2001; Birthal et al. 2014; Canagarajah et al. 2001; Block and Webb 2001). Perhaps diversified farms care more for stable income than specialized farms and, thus, they are also likely to use savings as a device for stabilized income. Lastly, in line with our expectation, we found that higher perceived survival risk leads to greater likelihood of financing through

savings. This may indicate that small farmers perceive saving as a device to combat risk, and that they build up reserves when they are subjected to higher perceived risk.

The third column of Table 2 presents factors influencing the extent of financing through off-farm income. We found that factors such as marital status of farm operator, land acreage holdings, farmer's continuation plan, and risk perception significantly influence the extent of financing through off-farm income. Our study found a strong positive relationship between marital status and financing through off-farm income. Involvement in off-farm activities is a way of improving the overall household income (Alasia et al. 2009). Farm-related activities may not be producing as much income as needed to cover agricultural expenses due to the high risks and uncertainties in farming. Married operators may have better prospects in off-farm work as they can balance and adjust with their spouse for involvement in off-farm work and generate supplemental income, as compared to a single operator. Our result is in line with the results from Lien et al. (2010), who found that farmers who are single are not as involved in off-farm related activities as farmers with partners. Our result suggests a negative relationship between land acreage holdings and extent of financing through off-farm income. This implies that farmers holding more land acreage can allocate less time and less involvement with off-farm activities; instead, they dedicate more time to farm-related activities. Additionally, we found a strong positive relationship of planning horizon (plans to continue farming for next 5 to 10 years) with financing through off-farm income. This result can be explained with respect to sustainability; in particular, small farms aim for stable income which can be achieved from a balance of off-farm and on-farm activities. Key et al. (2015) found that farm income has the most variability among all household income sources; hence, off-farm income stabilizes income flow and serves as a risk management tool. The risk perception variable, on the other hand, was found to have a negative influence on extent of financing through off-farm income. This indicates that farmers who think farming is a risky operation are less likely to use income from off-farm works to meet agricultural spending and expenses. This is plausible because the small farm operators perceiving their farming operation as risky may devote their off-farm income (a liquid asset) to some other investment rather than spending on agricultural or farm-related activities.

The fourth column of Table 2 presents model results estimating the extent of use of government-paid income/incentives. In government incentives use, the credit constraint variable had a strong negative effect. The negative association of credit constraint with the use of government subsidy is plausible, as low or no government payment is likely for credit-constrained farmers and, hence, they have less availability of government incentives to spend on agricultural activities. Our significantly positive coefficients on age, education, and diversification-related factors implies that older, more educated, and more diversified farmers are likely to use more government support incentives. Perhaps older and more educated farmers are able to show proof and ability to optimally utilize approved funds from the government. More diversified (farmers with a higher number of crop/livestock enterprises) small farms may be more considered as conservation and environmentally friendly farms than specialized farms. Thus, perhaps the diversified farms receive conservation- or environmental-related government payments and are more likely to use that payment. The results also show that gender, marital status, number of off-farm hours, and level of risk concern have negative impact on financing through government incentives/payments (Table 2, column 4).

The fifth column of Table 2 presents model estimates assessing factors influencing the extent of credit and loan use among small farms. The results show that factors such as credit constraint, age (below 35), gender, marital status, household income, and risk perception variables negatively influence the credit or loan use to meet farm expenses. The finding on credit constraint variable is as expected because one can expect a direct association of credit constraint with credit use. We also found that relatively younger farmers are less likely to finance through credit/loans. A plausible reason is that relatively younger farmers are less experienced in farming and may lack adequate information, knowledge, contact, or assets

relevant to apply for credit. [Wongnaa and Awunyo-Vitor \(2013\)](#) discussed that relatively older farmers have better access to loans because they are considered more responsible than younger borrowers. We found that the principal operator's college-level education or above positively influences the use of credit and loans to meet farm expenses. This might be linked to the role of education in the understanding of the financial institution's procedures, filling essential documents, and cordial communication with bank staff ([Elias et al. 2015](#)).

We also found a significant gender effect on the extent of financing through loans. A negative relationship suggests that farms with male operators are less likely to finance through credit/loans. This result is contrary to some studies that found a positive relationship between male and access to credit/loans ([Bembridge 1984](#)). Our model suggests that married farmers are also less likely to finance through credit/loans. Some previous studies claimed that married farmers living with their spouses have a tendency of making a solid agreement on the kind of investment to make, and they have a better plan on paying the credit ([Kiplimo et al. 2015](#)). However, these studies were focused on access to credit but not on the extent of financing through credit. Although married farmers are likely to have better access and approval to credit, they are also likely to deviate credit utilization for spending other than agriculture. Furthermore, other sources of funding are probably more likely than credit/loans for married farmers. Our model also shows that smartphone use positively influences the extent of credit. This is plausible because smartphone use in farmers may be an indicator of technologically advanced farmers with higher ability to access and utilize external credit and loans. Once a credit source can be located, credit access is highly facilitated ([Ayamga et al. 2006](#); [Rahji and Fakayode 2009](#)).

Lastly, we found that perceived survival risk significantly affects credit financing. Our results show that the farmers with higher perceived survival risk are less likely to finance through credit or loans. Risky agricultural operations may have less ability to establish a line of credit and collateral or receive credit; therefore, they may have a lower tendency to use external credits and loans.

4. Conclusions

This study examined and discussed how small farmers, who have limited financial assets, meet their agricultural expenses using different means. Using primary survey data of small farms in Tennessee, we investigated the different sources and the extent of use of these sources to finance farm-related spending and expenses. Specifically, we considered the extent of use of five different sources: cash/fund directly generated from the sale of agricultural products, farmer's past savings, farm household's off-farm income, income/incentives from government payments, and external loans/credit. We analyzed the factors influencing the extent of use of each of these sources. We collected a primary dataset through administering a survey of small farm households in Tennessee following standard survey and sampling methods.

Using a class of generalized linear regression models accounting for the count nature of the dependent variables, we found that the decision on the use of financing sources is significantly influenced in general by various demographic, economic, and risk factors related to farmers or farm households. However, the associated factors and their effects on the extent of use were different depending on the financing source. For example, the extent of financing through agricultural product sales was negatively impacted by the age of the farm operator and the household size, while the extent of financing through past savings was negatively influenced by factors such as education, gender, level of enterprise diversification, level of risk perception, and the use of a smartphone with internet access and positively influenced by age, household income, and operator's off-farm hours. On the extent of use of off-farm incomes, we found a significant positive effect of marital status and planning horizon and negative effects of farmland acreage and level of risk perception. Similarly, the use of government payment and incentives was affected by age, education, level of agricultural diversification, and level of risk concern.

With respect to extent of debt financing or use of loans, this study found that relatively older and more educated farmers are more likely to use credit or loans to meet their farm expenses, more than their counterpart younger and less educated farmers. Furthermore, the use of a smartphone with internet access and higher perceived survival risk of farming operations affect the extent of financing through credit/loans. We acknowledge that this study could gain further insight through the discussion and analysis of financial tools together with the adoption of risk management tools.

Small farms have limited financial assets and have constrained capacity toward resources. These small farms are subject to a greater challenge of adequately meeting their needs on farm-related spending and expenses. Demographic and socioeconomic variables have different degrees of effect on the extent of financing through different sources. On one hand, financing through a farm's direct money from agricultural product sales and past savings is a safer approach, but many small farms do not have enough resources generated through these means as they face survival challenges. On the other hand, high financial reliance on off-farm incomes and government payments/incentives not only depends on the farmer's access and exposure but also poses a risk of the farmer's deviation away from contribution to agriculture. Since credit-constrained small farms lack a strong collateral base and established line of credit, they find debt or loan financing difficult. A high degree of debt financing is considered relatively risky. Small farms need to find a balance of different financing means and ensure that the farm can withstand comfortably. This study contributes to the limited literature about the sources and extent of financing among small farms. Researchers, extension programs, and policymakers should keep in mind the demographic, farm, and farmer characteristics and their differential effect on the use of different financing sources depending on the target population.

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Notes

- ¹ Note that the definition of small family farm is based on the annual gross farm incomes of US farms defined by the US Department of Agriculture, which may not exactly correspond with the small farm context in developing countries or other emerging and advanced countries.
- ² While we captured some methods such as personal savings in our study, we did not exactly distinguish formal and informal sources of funding in the analysis of this study due to data limitations and the lack of distinct separation between formal or informal means in the data.
- ³ While we acknowledge the possibility of interlinked decision in determining the extent of financing among these financing sources, we estimated individual equations separately for simplicity of interpretation.
- ⁴ The survey questionnaire used in this data did not collect details of expenses about where funds are used. With this limitation, we were not able to exactly distinguish types of expenses incurred, long-term vs. short term expenses, or operating expenses vs. investment. Specifically, the item states “considering your past year, what was the source of funds to pay for your expenses in agricultural activities (indicate the level of percentage in each)”, and it provides a source list and categorical choices for extent of use on each source. Therefore, we represented it by annual agricultural/farm spending and expenses in this paper.

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