Factors affecting the adoption of risk management strategies by small farmers in Tennessee

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Selected paper prepared for presentation at the Southern Agricultural Economics Association (SAEA) Annual Meeting, Louisville, KY, February 1- February 4, 2020

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Abstract
Agriculture is a risky business, not only due to its sensitivity to factors like weather, diseases and pests, and other factors contributing to the adverse production but also due to price, finance, and market factors possessing challenges to maintain it as a viable enterprise. These challenges are even more prevalent among small farmers with limited capacity in production and financial resources. Appropriate risk management decisions are important to mitigate these challenges. This study analyzes the factors influencing risk management decisions among small farms in Tennessee. Using a primary survey data of 104 small farmers and multivariate probit regressions, we analyzed factors influencing multiple risk management decisions such as diversification, adoption of alternative agricultural enterprises, insurance participation and off-farm work, accounting for the simultaneous decision-making process. We further investigated on the determinants and likelihood of alternative farm enterprises adoption, particularly examining the adoption of single and combination of agritourism and on-farm processing strategies using multinomial logit model. Our multivariate probit results suggest significant correlations between risk management strategic decisions. In addition to the demographic and economic characteristics of the farmer and farm operations discussed in the previous literature, our result also suggests that the factors such as government payments, operator's continuation plan and use of smartphone significantly influence the decisions on the adoption of different risk management strategies among small farmers.

I. Introduction

Agriculture, by nature, is a risky business. Sometimes, farmers encounter harsh circumstances obstructing normal execution and ultimately leading to complete failure of farms (Janowicz-Lomott & Lyskawa, 2014). Although a panorama of risk management tools (Meraner & Finger, 2019) and government policies are prevalent, farmer's problems are still not addressed effectively (Aimin, 2010). Approximately, 88% of the US farms are small family farms with gross cash farm income (GCFI) below $350,000 accounting for 20% of the total sales (USDA, 2012). Small farms are the backbone of the rural economy and have the potential for providing many goods and services (Gebremedhin & Christy, 1996). Moreover, small farms, in general, have their operating profit margin (OPM) below 10% (considered as a red or risk zone) indicating high financial risk (USDA, 2017). This scenario explicitly identifies the importance of risk management strategies for small farms. Policy settings are putting greater emphasis on insurance-based strategies rather than direct payment plans that consider the risk management center of every program (Woodard, 2013). Agricultural production, being biological in nature, sensitive to different factors like weather, diseases, and pests, may not always perform as expected (Kahan, 2008). Total freedom from risk is not possible but its effect can be curtailed with the use of different tools like insurance (Gebremedhin & Christy, 1996). Moreover, another promising strategy could be allocating available resources to different farm enterprises (Huirne, Meuwissen, & Asseldonk, 2007). With this kind of diversification strategy, adopters are likely to generate more cash income than non-adopters (Khanal & Mishra, 2014). Huirne, Meuwissen, & Asseldonk (2007) implied that multiple risk management strategies could be more efficient. For small farms lacking enough resources to invest in modern expensive technologies, enterprise diversification can be an excellent strategy for survival and risk management (Mishra, El-Osta, & Sandretto, 2004). Similarly, Velandia, Rejesus, Thomas O. Knight, & Sherrick (2009) contend that from the portfolio of several risk management alternatives, farmers are likely to adopt multiple tools simultaneously.

Previous studies have examined a number of factors affecting the adoption of risk management strategies which mainly include demographic characteristics like age, gender, education status of farm operator, household size and education status of the operator spouse (Bartolini, Andreoli, & Brunori, 2014; Khanal & Mishra, 2015; Khanal & Mishra, 2014), farm-related characteristics like total farm area, governmental payments, debt to asset ratio, livestock, different crops (Khanal & Mishra, 2015) and geographical and county-related features like hill/mountain/plain, rural/urban (Bartolini, Andreoli, & Brunori, 2014), farm or government or mining or manufacturing or service dependent county, metro or non-metro counties (Khanal &

Mishra, 2015). Khanal & Mishra (2015) found that location of the farm, characteristics of farm and farmers, and financial state were strong deciding aspects of farm diversification. Likewise, Meraner & Finger (2019) reported that age, farm size, and perception of risk were also determining factors of risk attitude. Similar results were also found in a study by Velandia et al (2009).

Farmers' risk management strategies have been the subject of discussion in previous studies. Scholars have discussed strategies such as on-farm diversification (Bartolini, Andreoli, & Brunori, 2014) and both on-farm and off-farm diversifications (Khanal & Mishra, 2015; Mishra, El-Osta, & Sandretto, 2004) as risk management tools for farmers. Adoption of alternative farm enterprise such as agritourism, on-farm processing, certified organic facility etc. are also discussed as potential risk management and diversification tools for farmers (Khanal and Mishra, 2014; Joo et al. 2013). Additionally, several studies have discussed insurance participation decision as risk management strategy (Kumar, et al., 2011; Boyd at al., 2011; Finger & Lehmann, 2012; Ginder at al, 2017). However, very few studies have examined the effect of multiple strategies together accounting for simultaneous decision making process. For instance, Meraner & Finger, (2019) studied multiple aspects – sixteen different risk management strategies. Likewise, Khanal & Mishra (2015) also studied diversification strategies from several aspects and categories them under four broad headings: agricultural diversification, structural diversification, environmental diversification, and income diversification.

Recent few studies have highlighted the importance of analyzing simultaneous decision making process in diversification and risk management (Khanal & Mishra 2015; Velandia et al. 2009; Meraner & Finger 2019) rather than independent equations for individual strategies. These recent studies involved multiple risk management tools using multivariate probit and multinomial probit models and took possible association of these risk management tools into consideration.

However, very few researches on the adoption of multiple risk management strategies are on the small farms level especially in the developed world like the US**.** Additionally, none of the studies have closely examined the factors influencing and decisions regarding alternative farm enterprises like on-farm processing are on small farms level. Also, the addition of the factors like the use of a smartphone with internet access, government payments, and operator's continuation plan on the selection of risk management strategies could play important role but have been included in very limited previous studies.

Keeping this in view, we address this limitation in literature specifically focusing our study on simultaneous decisions regarding adoption of different risk management strategies among small farmers of Tennessee a state dominated by the vast majority of small farms—almost 95% of total farms. Our main objective is to analyze factors affecting the adoption of production risk management strategies among small farms of Tennessee. Specific objectives include: a) to find the correlation among different risk management strategies and test the interlinkage of the decisions b) to find determinants of risk management strategies such as crop insurance, crop/livestock diversification, alternative farm enterprises and, off-farm income. Additionally, to investigate on the single and combination of alternative farm enterprises (AFE) adoption among small farms, we specifically looked at the adoption decision of agritourism and on-farm processing and mix of these strategies using multinomial logit regression analysis.

II. Material and Method

Conceptual model

The conceptual model for risk management decision fundamentally derives from the revenue maximization objective from the given set of crop/livestock and agricultural enterprises and on- and off- farm strategic combinations as considering the minimization of overall loss.

Moreover, farmers are defined as a risk averse agent and we would expect higher likelihood of the adoption of risk management strategies with higher risk aversion.

The basic premise is that the presence of risk management tools fundamentally affects the net revenue distribution of each farmer. As a risk averse agent, the farmer examines his distribution and evaluates returns in choosing each risk management tool considering its associated cost. Moreover, risk management strategies incur some cost that can be through a reduction in total return by diversifying and/or shifting capital on less profitable but safer activities with intention to minimize variation in total return (Blank, 1990) or maybe in the direct form like paying for premium of insurance. In this article, it is assumed that risk averse farmer is likely to adopt more risk management strategies and safer business activities despite their low return. We further assume that farmer’s attitude towards risk is in turn reflected and represented in socioeconomic and institutional characteristics like age, farm size, and education (Lucas & Pabuagyon, 2011), access to market information (Iqbal et al., 2016), gender, household income (Wang & Watanable, 2016) and several farm characteristics like type of the crop, farm income and farm size (Sulewski & Kłoczko-gajewska, 2014).

Based on theoretical concept mentioned above, we delve into the determinants of risk management strategies like crop/livestock diversification, Alternative farm enterprises like (agritourism, on-farm processing), involvement in off-farm work and Insurance purchase. Following previous studies, we assume that risk management strategies are influenced by a variety of socio-economic and institutional characteristics of farm and farm operators (Velandia et al., 2009; Meraner & Finger, 2019). Therefore, equation for each strategy can be denoted by the generic form: $Y = f(X, \beta)$ where the decision to adopt strategy Y is a function of X which indicates a set of explanatory variables and corresponding β parameters define the relationship of each explanatory variable to the decision. In the section below, we show how we fit the equations representing risk management strategies in an econometric estimation framework.

Econometric Specification

To study factors determining the selection of an alternative from a set of option available like the adoption of multiple risk management strategies, two models are popularly used – multivariate probit and multinomial logit. Moreover, the fundamental assumption behind multinomial logit is 'independence of irrelevant alternatives' (Benson, Kumar, & Tomkins, 2016) widely known as IIA. The IIA states that among available alternatives, the addition of a new element decreases the likelihood of all other items by equal proportion (Benson, Kumar, & Tomkins, 2016). Train (2002) argued that IIA assumption, if violated, can lead to erroneous statistical inference and its relevancy has been questioned in many cases (Dow & Endersby, 2004). For our analysis, we use a multivariate probit model to assess the determinants of several risk management strategies: crop/livestock diversification, alternative farm enterprises, off-farm income, and crop insurance. The multivariate probit model (MPM) is useful while making statistical inferences of multiple dependent variables (which are closely associated) and independent variables (Chib & Greenberg, 1998). As strategies can replace and complement each other, their effects of the association are ensured using MPM when the decision is made simultaneously (Khanal, Mishra, and Omobitan, 2019).

The Multivariate model for the analysis, in accordance with the conceptual framework, will be like equation (1), a similar model used by Khanal, Mishra, and Omobitan (2019).

$$Y_{ij}^{*} = x'_{ij}\beta_i + \epsilon_{ij} \tag{1}$$

Where, $Y_{ij}^{*}(\mathrm{j} = 1, \ldots, \mathrm{m})$ represents the latent variable of net revenue for different risk management alternatives by the ith producer $(i = 1, \ldots, n)$. In our study, risk management strategies are four (m=4). Similarly, x'_{ij} denotes a set of explanatory variables determined exogenously, and ϵ_{ij} signifies the error term. For each risk management strategies$(\text{j} = 1, \dots, 4)$, representative equations can be shown as:

$$Y_{i1} = x'_i\beta_1 + \epsilon_{i1}\ (crop/livestok\ diverisficatin) \quad (2)$$

$$Y_{i2} = x'_i\beta_2 + \epsilon_{i2}\ (Alternative\ farm\ enterprise\ diversification) \quad (3)$$

$$Y_{i3} = x'_i\beta_1 + \epsilon_{i3}\ (off - farm\ work) \quad (4)$$

$$Y_{i4} = x'_i\beta_4 + \epsilon_{i4}\ (Insurance) \quad (5)$$

Suppose Y_i represents a vector of observed binary outcomes for producer i, $Y_{i1}, \dots, Y_{i4}$, defined by latent variables presented in equations such that Y_{ij} = 1 if $Y_{ij}^* > 0$, 0 otherwise, j = 1,…,4. While modeling multivariate probit, we assume the presence of possible correlation among error terms $(\epsilon_{i1}, \epsilon_{i2}, \epsilon_{i3}, \epsilon_{i4})$. Assuming a normal distribution of error terms, $E[\varepsilon] = 0,$ we can estimate the value of these unknown parameters from multivariate probit method—a class of limited dependent variable models fitted using a simulated maximum likelihood approach. The multivariate probit model assumes that the unknown parameters also called as error terms follow a multivariate normal distribution with mean zero and variance-covariance matrix p, where:

$$cov(\varepsilon) = p = \begin{bmatrix} 1 & \cdots & p_{14} \\ \vdots & \ddots & \vdots \\ p_{41} & \cdots & 1 \end{bmatrix} \quad (2)$$

The matrix has diagonal with all elements 1, whereas elements of the off-diagonal are correlations between respective diversification strategies to be estimated.

Sampling procedure and Data collection

Primary data was collected from Tennessee farmers through electronic mail survey using a structured questionnaire. This method of survey administration is considered cost-effective (Velandia et al., 2009). To receive higher number of responses, we sent several reminders to farmers on a regular basis. First reminder was sent three weeks after the survey was sent via email. second reminder was sent two weeks after the first one and third reminder was sent after a month of the second reminder. Enough responses are necessary to represent the population—Hill (1998) argues that the sample size should be at least 10% of the population while conducting descriptive research. Therefore, reminders were sent on a continuous basis until we got a satisfactory number of responses.

Contact details like phone numbers and email addresses were extracted from the Pick Tennessee Products organization database. The Pick TN Products database possess list of farmers running a variety of Agricultural enterprises like fruits, vegetables, herbs and mushroom, honey, dairy, meats, poutry, and eggs, certified organic as well as agritourism. In addition, the database encompasses farmers list categorized distinctly based on East, West and Middle regions along with respective counties of Tennessee. A sampling frame was defined using a stratified random sampling method based on counties and different categories of Agricultural enterprises. Total of 720 farms: 250 from East, 250 from Middle, and 220 from West Tennessee was sent in 2017. From a total of 720, we got 104 responses, a satisfactory number (14% response rate) to proceed for analysis. Before conducting the final survey, pre-testing of the questionnaire was done among farmers other than those targeted (not from targeted 750) to ensure the validity of the questionnaire and to make necessary corrections. The questionnaire includes fifty questions including socio-economic, demographic, and financial characteristics of farm and household under three broad sections: farm production and agricultural activities, farm financial information, and household information.

III. Result and Discussion

Descriptive and summary statistics

Figure 1 provides the proportion of farmers using at least one risk management strategy from the total sample. The percentage of farmers adopting at least one risk management strategy comprises 84% while those not adopting any of the strategies comprise a small portion (16%) of the sample. The percentage of each risk management strategies are shown in table 1. In our sample, 65% of the farms adopted crop or livestock diversification, 61% of the farms adopted alternative farm enterprises, 35% of the farms adopted off-farm work and 32% of the farm adopted Insurance as a risk management strategy.

Tables 2 shows categories of alternative farm enterprises adopted by sample household with percentage of each on total sample: ‘agritourism only’ (36%), ‘on-farm processing only (8%)’, ‘both agritourism and on-farm processing (17%)’, ‘at least one alternative farm enterprise (63’), and ‘none’ (37%).

In our study, around 35% of the sample farm are from east Tennessee, 33% from the middle Tennessee and 28% are from west Tennessee. Table 3 shows the percentage of each strategy adopted by sample farms from east, west and middle Tennessee. We found the highest percentage of crop/livestock diversification for the sample of east (46%) followed by middle (39%) and west (21%) Tennessee. Middle Tennessee, however, comprises the highest percentage (70%) of farm sample adopting alternative farm enterprise diversification strategy followed by the west (68%) and east (49%) Tennessee. Moreover, the percentage of producer working off-farm are in the order: east (40%), west (39%) and middle (0.27%) respectively. Our sample data shows middle Tennessee with the highest percentage (45%) Insurance purchaser followed by east (29%) and west (25%). Interestingly, all three regions – east (82%), west (79%), and middle

(79%) – have the almost same percentage of farmers adopting at least one category of risk management strategies.

Table 4 presents the definition and descriptive statistics of the independent variables used in the multivariate probit model. Our analysis is done on small farmers with annual income less than or equal to $350,000. In our sample, the average age of the primary operator is 53.29 years and the average education of the primary operator is 10.38 years, respectively. Moreover, the Average income of the household is $55,930.25 and the average landholding is 71.25 acres, respectively. Results suggest that 84% of the sample operators have access to smartphones with Internet access and 85% of them are planning to continue farming even in 5 or 10 years. Besides, 67% of the sample farm have family involvement on the farm activities. Furthermore, the Average share of the agriculture on total income is 67% and 18% of the sample farms have received government payments.

Results from multivariate regression

Table 5 shows the results of multivariate probit analysis on the relationship of explanatory variable on the likelihood of choosing a risk management strategy, ensuring the possible correlation, if any, among the strategies. A multivariate probit model is based on simulated likelihood approach. A significant likelihood ratio test result (with p-value 0.000) rejects the null hypothesis of no correlation between risk management strategies. This is an indication that our decision using multivariate probit instead of independent probit equations is an appropriate one. Moreover, it also points out that had we not controlled simultaneous decisions, the estimates would have been biased.

Interlinkage between risk management strategies

Bottom of the table 5 presents correlations and interlinkage between each risk management strategies. We found a significantly positive relationship between crop/livestock diversification and adoption of alternative farm enterprises (rho21, table 5). The complementarity of these decision is plausible because one would expect that having variety of crop and livestock in the farm, including different production practices—row and mixed cropping etc. would complement the adoption of alternative farm enterprise like agritourism—typically featured by tour, education, and recreational aspects of agriculture. Decision on another alternative farm enterprise like on-farm processing is also completed by the diversified crops and livestock. Consistent with our result, Mastronardi et al. (2015) argued that agritourism supports environment-friendly features like biodiversity.

On contrary, insurance and crop/livestock diversification decisions are significantly negatively correlated (rho 41, table 5) indicating that adoption decision of these strategies is competitive. One of the plausible reasons for this stem from the limited resource of small farmers. As small farmers are reluctantly allocating money on insurance and crop/livestock diversification, perhaps they like to choose one over another for overall risk management goal. As opposed to specialized farmers focused on concentrated one or two crop/livestock concerning highly about safety nets and loss from concentrated commodity, diversified farmers probably pay less attention to buy insurance, given limited resource capacity.

Our results show a complementary relation between insurance and alternative farm enterprises decisions (rho 42, table 5). Recall that alternative farm enterprise diversification includes income generating enterprises like agritourism and on-farm processing unit. By the nature of alternative farm enterprises, one needs to consider liability associated with the possible risk. For example, tour and recreational events of agritourism and having on-farm processing units require some level of capital and high-value assets. Therefore, perhaps the farmer adopting alternative farm enterprises are likely to care about safety and risk minimization by buying insurance. Finally, we also found a significantly negative correlation between insurance decision and off-farm work participation. Specific to our sample, part time farmers with outside job as main occupation or those focusing on off-farm jobs are perhaps less likely to buy crop/livestock insurance considering agriculture as the secondary source of income. On the other hand, those small farms decided to buy crop/livestock insurance perhaps have main focus on agriculture and are less likely to pursue off-farm jobs.

Factors influencing risk management strategies

Results in Table 5 show that the age of the primary operator has a significant effect on the type of risk management strategy chosen. Older farmers are likely to adopt more crop/livestock diversification and alternative farm enterprise diversification (AFE) as compared to younger farmers. Surprisingly, with second highest marginal effect of 0.0114 for crop/livestock diversification and highest marginal effect of 0.0113 for AFE, among equations of all four strategies. Our finding is consistent with Meraner & Finger (2019) and Potter and Lobley (1996), who argue that assumingly younger farmers are surplus in labor and deficit in financial resources and therefore adopt more production-related on-farm risk management strategies rather than off-farm tools.

Our results suggest that the operator's education has a positive effect on the adoption of crop/livestock diversification strategies with a high marginal effect of 0.0332. Result indicates that with the increase in formal education by 1-year, the likelihood of adopting crop/livestock diversification increases by 3.32%. The finding is consistent with Mishra et al. (2004). However, the results reflect a negative relation of education with the insurance purchasing decision. The result, rather counterintuitive, reflects that with a 1-year increase in formal education there decreases the insurance purchasing decision by 1.19%.

Results in Table 5 indicate a positive relationship between the acreage of farm and crop/livestock diversification. Although this seems counter-intuitive as large farm size is an indication of specialization and have less incentive to diversify (McNamara & Weiss, 2015), result is consistent with Bartolini et al. (2014), who argued that very small landholding is an indication of a barrier to diversification because of scarce land to allocate for different enterprises. Similarly, results show that land acreage has a positive relationship with the purchase of crop insurance. Even though this result is in contrast with some studies like Velandia et al. (2009), it may be plausible in our sample because high land acreage farms might have larger investment (a sign of high risk) and have higher incentive to purchase insurance. Moreover, higher land acreage is also a sign of higher capacity to capital and assets perhaps with less financial constraint to buy insurance.

We found that an increase in the share of agriculture on total income increases the likelihood of adopting crop/livestock diversification strategy. Marginal effect of 0.0021 signifies that probability of diversification increase by 0.21% with every percentage increase in the agricultural income share. This may be because farmers become more cautious when a large part of their income comes from Agriculture. Likewise, results found by Khanal et al. (2019) infer a similar idea—operators with agriculture as their main occupation are more likely to adopt diversification strategies than the one with other main occupations (Khanal et al., 2019) Additionally, Table 5 shows a negative relationship between agriculture's income share and operator's involvement in off-farm works. This result is consistent with our expectation as the agriculture share on total income with off-farm work has the exact opposite relation as has with the crop/livestock diversification. Marginal effect of 0.0056 indicates that the farmer with 1% increase in income share from agriculture increases likelihood of off-farm work by 0.56%. A probable reason could be that farmers with low income from agriculture involve on off-farm work to supplement financial requirements considering the long-term survival of small farm operations through these additional incomes.

Our results also show a negative relationship between government payment and crop/livestock diversification. The magnitude of marginal effect shows that government payment decreases the chance of choosing crop/livestock diversity by 26.05%. This result is counterintuitive to our expectations. A possible explanation could be that the government's payments make farmers specialized on subsectors that are aimed for. We found a positive relationship between government payment and off-farm work—marginal effect of 0.23. A similar relationship between off-farm work and government payment program was found by Khanal & Mishra (2014). One of the reasons for this might be that government payments could make farmers less concerned about farming because of their less personal investments. Therefore, farmers instead of giving more time to agriculture, end up working off-farm. Additionally, our results show that government payments has positive relationship with likelihood of insurance. A plausible reason could be that the government payment enhances farmer's financial strength and therefore they are likely more flexible for price of the insurance premium.

Results in Table 5 shows that smartphone with Internet access has a significant positive relationship on alternative farm enterprise diversification. A marginal effect of 0.25 indicates that farmers with smartphones with Internet access are likely to adopt alternative farm enterprises

25% higher than those without smartphones. This finding is consistent with Bartolini et al (2014). Smartphones with Internet access make farmer up-to-date with market information and new agricultural strategies prevailing around the globe. Smartphones with Internet access increase the farmers' communication with other farmers and related stakeholders. McElwee & Bosworth (2010) found that the farmers with internet access have advantage to quick networking ability and have better and first-hand information about new innovations and developments which likely to enhance their ability to adopt innovative income generating enterprises.

Finally, our multivariate probit results show significant effects of household income and farm's continuation plan on the adoption of risk management strategies. We found a positive effects of income on the adoption of alternative farm enterprises. High income indicates financial strength which may enable farmers to allocate money on farm enterprises like on-farm processing and agritourism. Another interesting result is the effect of planning horizon—our results show that farmers planning to continue farming in next 5 or 10 years are 28.34% more likely to engage in income diversification like off-farm work. This suggests two aspects. First, some farmers with off-farm work may be doing agriculture as a recreational propose, hobby farming, or as a part-time leisure job. This also includes retirees from full-time farmers doing part-time off-farm work and planning to farm on a very small scale for recreational purpose. Second plausible aspect is that perhaps farmers with continuation plan consider agricultural operation for long term sustainability perspective and income generation through a mix of on- and off- farm diversification activities likely serve as long term survival for small farmers with limited resources. Small farms are continuously struggling for survival and are persistent under pressure (Hoppe et al., 2010).

Results from multinomial logit regression

The Results from the multinomial logit model are presented in Table 6. The model is significant as indicated by Chi^2 statistics value of 61.35 (p-value 0.0002) and a good model fit indicated by Pseudo-R^2 of 0.25. Particularly, a relatively higher 0.25 of Pseudo-R^2 (for a nonlinear model like multinomial logit) indicates a well explanatory power of independent variables included in the model. The model shows a significant negative relationship between the age of the operator with all independent categories of alternative farm enterprise diversification strategies: 'agritourism only', 'on-farm processing only' and 'both agritourism and on-farm processing'. The magnitude of marginal effects shows that with additional year of the operator's age of the primary operator, the likelihood of choosing 'agritourism only', 'on-farm processing only', and 'both agritourism and on-farm processing' decreases by 0.19%, 0.44%, and 0.75% respectively. Our result is consistent with Mishra et al (2004). The authors argue that older farmers are relatively wealthier and wealthier farmers are less risk-averse. Therefore, older farmers are less likely to diversify.

A significant positive relationship is found between the use of the smartphone with internet access and the selection of 'agritourism only'. The magnitude of marginal effect indicates that with the use of smartphone the likelihood of adopting agritourism only increases by 42%. The result matches our expectations and also consistent with McElwee & Bosworth (2010) who showed that an access to the Internet builds up communication with markets and help establish relation with different networks of agribusiness. Therefore, it allows farmers to get well acquainted with innovative strategies. Additionally, our results show that every percent increase in share from agricultural income increases likelihood of adopting 'on-farm processing only' by 1.05%. The result is consistent with our expectation as alternative enterprise adoption like on-farm processing unit may need initial capital investment and farmers with relatively higher income and focus on agriculture are likely to adopt that strategy.

IV. Summary and conclusion

Agriculture is sensitive to factors like weather, diseases and pests, finance and market. There has been a tremendous scope for risk management. Especially farms with limited capacity in production and financial resources are more prone to such circumstances. To examine factors influencing risk management strategies, we conducted a primary survey among small farmers in Tennessee. Particularly, we examined the factors influencing the adoption of four risk management strategies: crop/livestock diversification, alternative farm enterprises, off-farm work, and insurance. Additionally, we allowed scope for a possible correlation between these risk management strategies while making a simultaneous decision. We found that estimates would have been biased had we assumed independence of alternatives or had we not considered possible correlation to exist.

From the multivariate model analysis, we found that the risk management decision strategies are interlinked. We found a complementary relation between crop/livestock diversification and adoption decision of alternative farm enterprises. We also found a positive relation between alternative farm enterprise diversification and insurance participation decisions. On the other hand, we found a negative relationship between crop/livestock diversification and insurance participation. Model results show that demographic factors such as primary operator’s age, education, planning to continue farming, access to a smartphone with the internet significantly influence the adoption and selection of risk management strategies. Additionally, land acreage, household income, government payment and agriculture share on income also influence the adoption of the diversification strategies. Also, results from multinomial logit show that age, the share of agriculture on total income and the use of smartphones significantly influence the adoption of single and combination of alternative farm enterprises.

Our results provide some interesting insight into holistic decision analysis of small farmers who are subjected under continuous survival challenges. Understanding of this decision making process provides the idea of cooperative, complementarity, and competitive risk management strategies for small farms. Investigating on the socio-economic, demographic, financial factors influencing the adoption of single, mixed, and combination of risk management strategies help researchers, policy makers, extension personnel, and educators to strategize and prioritize the support.

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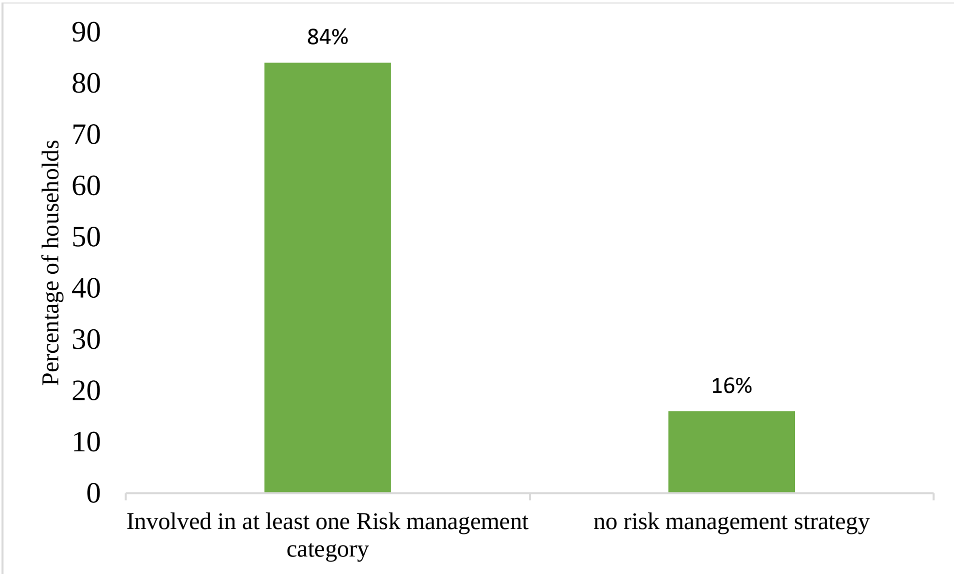

Figure 1 Farms involved in at least one risk management strategies: crop/livestock diversification, Alternative farm enterprises, off-farm work, or insurance

Table 1 Percentage of sample farm with different risk management strategies

Risk Management strategies	percentage of total farms
Diversification	65.00%
Alternative Farm enterprises	61.00%
off-farm work	35%
Insurance	32%

Table 2 percentage of sample farms adopting different alternative farm enterprises

Alternative farm enterprises	**Percentage of sample farms**
Agritourism only	36
On-farm processing only	8
Both Agritourism and on-farm processing	17
At least one alternative farm enterprise	63
None	37

Table 3 Percentage of sample farms adopting different risk management strategies in east, west, and middle Tennessee

Location	Variables	Mean	Std. Dev.
East Tennessee	Crop/livestock diversification	0.46	0.51
	Alternative fam enterprise diversification	0.49	0.51
	Off-farm work	0.40	0.50
	Insurance	0.29	0.46
	At least one risk management strategy	0.82	0.39
West Tennessee	Crop/livestock diversification	0.21	0.42
	Alternative fam enterprise diversification	0.68	0.48
	Off-farm work	0.39	0.50
	Insurance	0.25	0.44
	At least one risk management strategy	0.79	0.4
Middle Tennessee	Crop/livestock diversification	0.39	0.50
	Adoption of alternative farm enterprise	0.70	0.47
	Off-farm work	0.27	0.45
	Insurance	0.45	0.51
	At least one risk management strategy	0.79	0.4

Table 4 Variable definition and summary statistics

Variables Definitions	Mean	Std. Dev.
Age (age of the principle farm operator)	53.29	10.38
Education (years of schooling of principle farm operator)	14.06	2.79
Log of income (log of the total household income)	5.56	9.08
Income (total household income)	55930.25	47098.40
Log of acres (log of the total acres of the farm)	2.52	2.76
Acres (total farm acreage in acres)	71.58	129.78
Smartphone (= 1 if principle operator use smartphone with internet access)	0.84	0.37
Continuation plan (= 1 if principle operator expects to farm for next 5 or 10 years)	0.85	0.36
Family involvement (= 1 if family members other than principle operator also involve on farm activities)	0.67	0.47
Share of Agriculture (percentage of agriculture on total household income)	26.93	32.87
Government payment (= 1 if farm household received any type of government plan)	0.18	0.39
Number of Observations	100	

Table 5 Factors affecting adoption of risk management decisions estimated using the multivariate probit approach

Independent Variables	Crop/Livestock Diversification		Alternative Farm Enterprise Diversification(AFE)		Off-farm Work		Crop/Livestock Insurance	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Age	-0.0399** (0.0174)	-0.0114 (0.0051)	-0.0359** (0.0165)	-0.0137 (0.0044)	-0.0111 (0.0169)	-0.0032 (0.0051)	-0.0131 (0.0163)	-0.0022 (0.0048)
education	0.1131** (0.0498)	0.0332 (0.0152)	-0.0056 (0.0524)	-0.0032 (0.017)	0.0303 (0.0548)	0.0119 (0.0169)	-0.087* (0.0509)	-0.0171 (0.0151)
Log of income	-0.0005 (0.0166)	0.0003 (0.0056)	0.0329* (0.0172)	0.006 (0.0051)	0.0018 (0.0188)	0.0007 (0.0057)	-0.0172 (0.0174)	-0.0009 (0.0052)
Log of acres	0.1804** (0.0772)	0.0494 (0.0221)	-0.0949 (0.0661)	-0.0241 (0.0185)	0.00009 (0.0647)	0.0005 (0.0196)	0.2224* (0.0842)	0.0542 (0.0238)
smartphone	-0.4603 (0.4444)	-0.1167 (0.137)	0.8505* (0.3905)	0.2524 (0.1153)	0.6439 (0.4645)	0.2035 (0.1392)	-0.04 (0.4363)	-0.0346 (0.1226)
Continuation plan	-0.1295 (0.4527)	0.0077 (0.1428)	-0.3022 (0.4452)	-0.0904 (0.1267)	0.8592* (0.5076))	0.2834 (0.1475)	-0.1981 (0.458)	-0.0258 (0.1349)
Family involvement	-0.0826 (0.3241)	-0.0325 (0.1428)	0.2186 (0.3117)	0.0457 (0.0936)	0.017 (0.3185	0.0053 (0.0984)	-0.491 (0.3216)	-0.1762 (0.0884)
Share of Agriculture	0.0081* (0.0046)	0.0022 (0.0014)	0.0069 (0.0047)	0.0019 (0.0014)	-0.0194** (0.0059)	-0.0058 (0.0015)	0.0023 (0.0045)	0.0005 (0.0014)
Government pay	-0.9925** (0.4389)	-0.2605 (0.127)	-0.2951 (0.3977)	-0.11 (.00014)	0.7806* (0.4508)	.2323 (0.1309)	0.8053** (0.3784)	0.2215 (0.1111)
Constant	0.1362 (1.5171)		1.6992 (1.482)		-1.2312 (1.6288)		1.164 (1.5276)	
Joint-decision parameters	AFE & Diversification (rho 21)		0.4765** (0.1377)		off-farm work & diversification (rho31)		0.039 (0.180)	
	Insurance & Diversification (rho41)		-0.3679** (0.1862)		off-farm work & AFE (rho32)		0.061 (0.176)	
	Insurance & AFE (rho42)		0.3779** (0.1734)		Insurance & off-farm work (rho43)		-0.301* (0.184)	
Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 19.2248, Prob > chi2 = 0.0038								
Wald-Chi-square statistics of overall fit: 86.01 (Prob > chi2, 0.0000);								
Log likelihood: - 203.05851								

Note: Parameter estimates are based on multivariate probit model fitted using simulated maximum likelihood method. Figures in parenthesis are standard errors. * represents level of significance at 10%, ** represents level of significance at 5% or higher level

Table 6 Factors affecting adoption of single and combination of alternative on-farm enterprises multinomial logit regression results

Variables	None (base)	Agritourism only		On-farm processing only		Both Agritourism and on-farm processing	
		Coefficient	margin	Coefficient	margin	Coefficient	margin
Age		-0.0583* (0.0319)	-0.0019	-0.1148* (0.0554)	-0.0044	-0.1280* (0.0501)	-0.0075
education		-0.0740 (0.1063)	-0.023	0.0968 (0.1805)	0.0066	0.1463 (0.1482)	0.0153
Log of income		0.0446 (0.0336)	0.0060	0.0652 (0.0662)	0.003	0.0106 (0.0516)	-0.0019
Log of acres		-0.1736 (0.1213)	-0.0272	-0.0258 (0.2044)	0.0043	-0.0968 (0.1714)	-0.0005
smartphone		1.8508** (0.9243)	-0.4248	0.0412 (1.1394)	-0.27	17.0353 (1693.68)	1.4583
Continuation plan		-0.2602 (0.8298)	0.0531	-1.8383 (1.2745)	-0.1005	-1.1271 (1.3865)	0.0664
Family involvement		0.7382 (0.6157)	0.2002	-0.2220 (0.9261)	-0.01885	-1.2516 (0.9546)	-0.0144
Share of Agriculture		-0.0048 (0.0112)	-0.0031	0.0105* (0.0153)	0.0003	0.0431 (0.0133)	0.004
Government pay		-0.1377 (0.8016)	0.0551	-0.9296 (1.2975)	-0.0421	-1.2225 (1.1180)	-0.0924
Constant		2.6395 (2.9689)		4.3221 (4.6313)		-12.2947 (1693.684)	
Overall model significance and model fit				Pseudo-R^2		0.25	
				LR-chi^2(27)		61.35	
				Prob> chi^2		0.0002	
				Log likelihood = -93.155895			

Note: Figures in parenthesis are standard errors. * represents level of significance at 10%, ** represents level of significance at 5% or higher level