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NAVIGATING FARMING RISKS BY SIMULTANEOUS DIVERSIFICATION AND CREDIT THROUGH FORMAL AND INFORMAL COMMUNICATION CHANNEL

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ABSTRACT:- Main purpose of the study is to investigate the role of access to information on farmers' risk management adoption decisions keeping in view the potential correlation between these risk management adoption decisions. Bivariate and multinomial probit models are used to assess the impact of access to information on farmers' risk management adoption decisions using data collected from 330 randomly selected respondents from four districts of Khyber Pakhtunkhwa Province of Pakistan. Bivariate and multinomial probit models take into account the possibility of simultaneous adoption of the two risk management tools at the same time. The decisions to adopt diversification and agricultural credit for risk management are correlated and adopting one risk management tool may make it more likely to adopt the other tool at the same time. Moreover, access to formal sources of information significantly encourages the use of both of the risk management tools to manage farm risk. Based on the information from the bivariate and multinomial probit approaches the agricultural extension educators can also improve their programs to guide the farmers in a better way and target farmers who need risk management information the most. At policy level, emphasis may be given to formal training and awareness of the farmers for diversification to compensate production risks. The existing extension network can be strengthened through its institutional linkage with metrology department and information communication technologies to further inform and train the farmers about disasters and disaster associated risks.

Key Words: Information access; Risk Management; Bivariate Probit; Multinomial Probit.

INTRODUCTION

Risk is a normal part of the agricultural environment and growers should use risk management strategies to reduce the potential impact of risk on their farm activities. Agricultural risks rise mainly due to the climate variability and change, the complexity of biological processes, the seasonality of production, the geographical separation of production region and end users of agricultural commodities (Arce 2010). Frequent natural disasters, the yield and prices variability of farm products, imperfect input/output markets and the absence of financial facilities along with limited extent and design of risk mitigation tools such as credit and insurance also threaten the viability of

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this important sector of the economy (Jain and Parshad 2007). These factors not only alter farmers' incomes and livelihoods but also challenge the viability of the farm sector and its capability to play its part in alleviating the problem of widespread poverty of agricultural producers (Raju and Chand 2008). Managing these uncertainties and risks in agriculture is crucial as it affects other sectors of the economy (Kammar and Bhagat 2009) and is generally considered as a key matter in farmers' decision-making and to the policies that affect these decisions (Robison and Barry 1987).

The most useful asset a farmer can have to help with the management of risk is good information (Ngathou et al. 2006). Information has an extensive and multifaceted role in agriculture (Mettal and Mehar 2013) particularly in increasing agricultural production and improving marketing and distribution strategies of farm and farm-related firms (Rehman et al. 2013). It empowers farmers to respond to different types of risk, market incentives and competition more efficiently. Access to agricultural information can enhance the productivity (Olawoye 1996); affect the risk attitude of farmers (Ayinde 2008) and guide them to adopt sophisticated risk management tools to overcome the risks and uncertainties.

Studies have shown that most farmers have access to a variety of traditional information sources (Television, Radio, Newspapers, other farmers, government agricultural extension services, traders, input dealers, seed companies and relatives), which they regularly access for agricultural information (Mittal & Kumar 2000; Sarvanan 2011). Agricultural extension plays a key role in information and technology transfer (Fan & Hazell 1999; Mittal & Kumar 2000) and has a strong reliance on information exchange among farmers (Rehman et al. 2013). However, agricultural extension systems-especially those that are state-managed in South Asia - have limited outreach (Mettal and Mehar 2013). The possible reason may be the shortages of trained personnel, rising delivery cost, and the need for rapid response to changing climate and markets.

Along with the public extension services, farmers access information from a variety of other sources including Television, Radio, Newspaper, Magazine, Private Consultants, fellow farmers, relatives and friends, input dealers etc. Farmers use information from these sources to guide their farm activities in a risky and uncertain condition and make rational risk management decisions. However, literature on the role of various information sources on farmers' risk management adoption decisions is limited particularly for developing countries including Pakistan. The present study is therefore, designed to investigate the role of socio-economic and demographic characteristics and various information sources on farmers' risk management adoption decisions using a bivariate probit and multinomial probit approaches which takes in to account the possibility of simultaneous adoption of multiple risk management tools at a time.

MATERIALS AND METHOD

Study area and sampling

The present study is conducted in Khyber Pakhtunkhwa province of Pakistan with the main aim to investigate the potential impacts of farmers' access to various information sources on their decisions to adopt diversification and agricultural credit to manage farm risks. Four districts,

namely district Peshawar, district Charsadda, district Swat and district Shangla are selected as study area using a multi-stage sampling technique. The main reason behind the selection of these four districts is that two districts, Peshawar and Charsadda, are located in Peshawar valley and the farmers have relatively higher access to input output market, extension and other publicly provided services, credit, information etc. While Swat and Shangla are relatively less developed districts and the farmers have limited access to markets, information, agricultural extension services and other government provided services and are less adoptive of modern technologies (Ahmad et al, 2007 and Shahbaz et al, 2010). Two villages in each district are randomly selected and a sample size of 330 respondents is randomly selected from the study area.

Modeling and Estimation

There is always possibility of contemporaneous correlation among farmers' risk management adoption decisions i.e. it is possible for a farmer to adopt multiple risk management tools at the same time. Keeping in view the potential for simultaneous adoption of the risk management tools, bivariate and multinomial probit models are used in this study. The two risk management strategies considered for the study are the use of diversification and agricultural credit to suppress risks faced by farmers.

Bivariate Probit Model

Bivariate probit model considering the possibility of contemporaneous correlation in the decisions to adopt diversification and agricultural credit as risk management strategies can be specified as follows:

$$Y_{ij} = X_{ij}\beta_j + \varepsilon_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where Y_{ij} (j =1,...,m) represent the risk management alternatives (in our case m = 2) faced by the i^{th} producer (i =1,..., n), X_{ij} is a 1× k vector of observed variables that affect the risk management adoption decision, β_j is a k ×1 vector of unknown parameters (to be estimated), and ε_{ij} is the unobserved error term. In this specification, each Y_j is a binary variable and, thus, equation (2) is actually a system of m equations (m = 2 in this case) to be estimated:

$$Y_1^* = \alpha_1 + X\beta_1 + \varepsilon_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$
$$Y_2^* = \alpha_2 + X\beta_2 + \varepsilon_2$$

Where Y_1^* and Y_2^* are two latent variables underlying each of the risk strategy adoption decision such that y_j=1if y_j >0;0 otherwise. The ε_{ij} elements of likely will experience stochastic dependence. This dependence among the elements of can be considered by assuming ε_{ij} that is multivariate normally (MN) distributed (Ashford and Sowden 1970). Hence, in the bivariate probit approach the error terms (across j=1,...,m alternatives) are assumed to have MN distributions with mean vector equal to zero.

Multinomial Probit Model

In case of multinomial probit model, the choice set is the possible combinations of risk management tools instead of just the risk management alternatives by themselves (Valendia et al, 2009). For the two risk management alternatives, there are four possible combinations (2^2) hat a farmer can choose to adopt: (1) use no risk management tool considered in this study (2) use diversification only, (3) use agricultural credit only, (4) use both

diversification and agricultural credit at a time. Given this choice set, a multinomial probit model can be specified as follows:

$$Y_{i} = X_i\beta+\varepsilon_i, \quad \varepsilon_i \simeq MVN(0,\Sigma) \qquad (4)$$

Y_i in this case represents the risk management tool combination (Y_i = 1, .., m) that the i^{th} respondent (i = 1,.., n) chooses, x_i is a 1 x K vector of observed variables that affect the risk management combination chosen, β is a k x 1 vector of unknown parameters (to be estimated), and is a k x 1 vector of unknown parameters (to be estimated), and is the unobserved error term. The unobserved error term in this case is assumed to be multivariate normal with mean zero and variance-covariance matrix Σ.

Variables and their Descriptions

Dependent Variables

Formal/state owned risk management instruments such as agricultural/crop insurance is relatively underdeveloped in Pakistan (FAO 2011 p-189). Crop Loan Insurance Scheme (CLIS) has been introduced in Pakistan since 2008 however, during the field visits it was revealed that majority of farmers are unaware of the scheme and stick with the traditional techniques to manage risk at farm. Therefore, the present study investigate the farmers' decisions of using traditional risk management tools i.e. diversification and agricultural credit.

a) *Diversification*: Diversification is one of the basic and obvious approaches used since mankind began to engage in agriculture (Tangermann 2011). Among the many uses of diversification, its important role in risk management is considered for the study and included in the analysis as 1 if the farmer uses diversification only for the purpose of risk management and 0 otherwise.
b) *Agricultural Credit*: There are numerous uses of agricultural credit in farm operations/activities, however, in this study its value depends on the farmers' decision to utilize credit only for the purpose of risk management. If the farmer uses credit for the sole purpose of risk management its value is 1 and 0 otherwise.

Independent Variables

The socio-economic and demographic factors included in the study are age, education and farming experience of the household head, monthly household off-farm income, farm size of the farming household and the proportion of own land.

a) Age of the household head is a continuous variable and measured as number of years.
b) Education of the household head is continuous variable and represents number of schooling years of the household head.
c) Farming Experience of the household head is also continuous variables and measured as number of years of farming of the household head.
d) Monthly household off-farm income represents all incomes except on-farm income earned by the sample household measured in PKR.
e) Farm size is a continuous variable referring to the total land operated by the farming household measured in hectares.
f) Proportion of own land is the ratio of own land in hectares to the total land operated by the sampled household.

g) Access to Information Sources: There are 8 information sources considered for the study including extension worker, Television (TV), Radio, Newspaper, private consultants, fellow farmers, relatives and friends and input dealers. Each information source represents a variable in the model and number of contacts an individual farmer made with the above information sources per cropping season is recorded for the variable. Hence the variables representing the information sources are the number of contacts farmers made with each of the information sources.

RESULTS AND DISCUSSION

Descriptive Statistics

The study is aimed at assessing the impact of access to information on farmers' risk management adoption decisions keeping in view the potential for simultaneous adoption of the two risk management tools at a time. The descriptive statistics of the variables used in the analysis are presented in Table 1. More than half of the sampled respondents are using diversification to manage farm risk while 40 percent are using agricultural credit to protect their farm from any negative shock. Among the information sources available to the farmers, fellow farmers are reported to be the largest source used by the farmers as fellow farmers are readily and easily available.

Information gleaned through input dealers account for the second largest source of information in the area. Farmers in the area seek guidance from input dealers in many farm activities particularly in activities related to production. Relatives and friends account for the third largest sources of information available and being used by the farmers in the area. Information acquired through, Private Consultants, Newspaper, Extension Worker and Television is relatively low in the study area.

Results of the Bivariate Probit Model

The parameter estimates of the bivariate probit model are presented in Table 2. A correlation co-efficient is calculated to assess the correlation between farmers' decisions to adopt diversification and agricultural credit to manage farm risk. The coefficient is the pairwise correlation between the error terms of the two equations in the bivariate probit model. The positive and significant correlation co-efficient (.439) indicates that the decisions to adopt diversification and agricultural credit for farm risk management are correlated and adopting

Table 1: Descriptive Statistics of the Variables used in the Analysis

Variables	Mean	Std. Dev.	Min.	Max.
Dependent Variables				
Diversification	0.52	0.50	0	1
Agricultural Credit	0.41	0.49	0	1
Explanatory Variables				
Farm and Farm Household Characteristics				
Age	48.24	13.16	19	80
Education	3.88	5.28	0	16
Farming Experience	28.32	14.99	3	65
Monthly Off	9050.91	7250.47	0	50000
Farm Size	5.67	2.98	1	13
Proportion of own land	0.47	0.44	0	1
Access to Information Sources				
Extension Worker	0.27	0.44	0	2
Television (TV)	0.22	0.56	0	4
Radio	0.36	0.66	0	4
Newspaper	0.14	0.38	0	2
Private Consultant	0.04	0.19	0	1
Fellow Farmers	2.65	2.01	0	10
Relatives and Friends	0.46	1.04	0	6
Input Dealer	0.58	0.64	0	2

Source: Derived from Survey Data 2012-13. Abbreviation for Pakistani currency (1 PKR approximately equals 0.01 USD)

one risk management tool may make it more likely to adopt the other tool at the same time. The positive and significant likelihood ratio test of ρ_{kj} (12.43) and the signi-ficant wald chi2 test value (167.11) justify the use of bivariate probit model and the hypothesis H0 of conjoint nullity of ρ_{kj} can be rejected.

Factors Affecting Adoption of Diversification

The significant variables in the adoption equation of diversification are age, education and farming experience of the household head, household off-farm monthly income and access to information from input dealers. Older farmers are likely to diversify compared to their younger counterpart. One possible explanation can be the fact that older farmers are generally risk averse in nature and will try to avoid risky situation and will prefer lesser income with lesser risk compared to higher income associated with higher risk. More educated farmers are likely to adopt diversification as they have more ability to assess the merit of diversification as a strategy to cope with the negative. Education of the household head expands his/her knowledge on the use of risk management tools to overcome risks at farm and help in making rational decisions.

A more experienced farmer will tend to avoid diversification to manage farm risk. Farmers with more experience will generally stick to his/her farming pattern and will try to avoid any form of diversification. This finding is in accordance with Mesfin et al. (2011) who also reported an inverse relationship of farmers experience and their adoption of diversification. Farmers with higher off-farm incomes are reported here to be more interested in adopting diversification to offset any negative shock to their agricultural enterprise. Higher incomes from off-farm incentives induce farmers to seek off-farm employment opportunities for income augmentation and to smooth their consumption when their farm incomes are altered by negative shocks. Information gleaned through input dealers significantly discourages the use of diversification to manage farm risk. The results revealed that larger farm size and higher proportion of

Table 2. Parameter Estimates of the Bivariate Probit Model

Variables	Diversification	Agricultural Credit
Farm and Farm Household Characteristics		
Age	0.0401***	-0.0046
	(0.0125)	(0.0120)
Education	0.0621***	0.0299
	(0.0193)	(0.0185)
Farming Experience	-0.0305**	-0.0128
	(0.0144)	(0.0157)
Monthly Off-Farm Income	0.00006***	-0.00002**
	(0.00001)	(0.00001)
Farm Size	-0.0318	0.0576
	(0.0498)	(0.0602)
Proportion of own land	-0.1809	-0.0708
	(0.1794)	(0.1847)
Access to Information Sources		
Extension Worker	0.1302	1.4610***
	(0.1975)	(0.2104)
Television (TV)	-0.0041	0.3448**
	(0.1582)	(0.1741)
Radio	0.0422	004132***
	(0.1285)	(0.1440)
Newspaper	0.1176	0.3910
	(0.2711)	(0.2836)
Private Consultant	0.1183	-0.1945
	(0.4485)	(0.4727)
Fellow Farmers	0.0421	-0.1182***
	(0.0422)	(0.0449)
Relatives and Friends	-0.0449	-0.2622***
	(0.0785)	(0.0895)
Input Dealer	-0.6572***	-0.1286
	(0.1311)	(0.1389)
Log Likelihood Value	-335.8357	
Wald Test Chi2(48)	167.11***	
LR Test of ρkj	12.43***	
Correlation Co-efficient	0.439***	
Total Number of Observations	330	

*Note: ** and *** represents statistical significance at 5% and 1% probability levels*

own land discourages the adoption of diversification to manage farm risk. Larger proportion of owned land and larger farm size are related to greater wealth, greater stability of land control, and a larger asset base that signals a larger capacity for bearing risk and a lesser need for risk management instruments (Velandia et al. 2009). However, their effect on the decisions to adopt diversification is insignificant in our case.

Among the information sources, extension worker, radio, newspaper, private consultant and fellow farmers facilitate the adoption of diversification to manage farm risk however; their effect is insignificant. The access of the farming household to extension services has positive impact on their ability and willingness to take risk. Extension workers facilitate farmers to make accurate farm production and risk management decisions. Radio can be used to expand the sharing of agricultural information by remote farming communities (Chapman et al. 2003). Radio is a convenient mean of disseminating agricultural information to masses. Use of Radio, rather than Television, to acquire agricultural information in the study area is a common practice. Newspaper is also an important source of information for farmers and the advantage of Newspapers over other mass media tools can never be under mined. The information gleaned through Newspaper can be documented for future references which other mass media tools such as radio and Television cannot provide. Information acquired from these sources can help farmers improve their risk management skills. They can help farmers recognize and understand their problems and assist them in making better farm management decisions. On the other hand, the use of Television and relatives and friend as a medium of accessing information discourages the use of diversification. One possible explanation for the negative relation of Television on the adoption of diversification is the lesser usage of Television in the study area particularly in the farming communities along with insufficient programs related to agriculture on the Television. The inadequate reliability of the information shared can be the cause of inverse relation between access to information through fellow farmers and adoption of diversification.

Factors Affecting Adoption of Agricultural Credit

Significant variables in the adoption of agricultural credit equation are off-farm monthly income, access to information sources including extension workers, Television, Radio, fellow farmers and relatives and friends. Higher off-farm incomes indicate a greater capacity to bear risks (i.e., because of stability of income, the possibility of "self-insurance") and may reduce incentives of borrowing. Producers with higher off-farm income have adequate financial reserves to guide their farm enterprise in hard times and therefore reducing the possibility of obtaining credit. Our results reveal that access to formal information sources significantly encourages the adoption of agricultural credit as risk management tool. The formal sources of information expand farmers' knowledge on institutional lendings and consequently encourage the use of credit to suppress the risk at farm. Extension workers, Television and Radio programs induce farmers to

avail the opportunities of credit to manage farm risks and continue earnings their livelihoods from agricultural sector.

In contrast, the informal sources (private consultant, fellow farmers, relatives and friends and input dealers) of information discourage farmers to opt credit as a risk reducing instrument. The lower access to formal/institutional sources (extension services, TV, radio and newspaper) of information may induce farmers to seek information from the informal sources to fulfill their information needs. The inefficient reliability of the information and knowledge shared through informal means may compel the farmers to avoid the use of agricultural credit in managing farm risks.

Results of Multinomial Probit Model

As discussed above, it is a common practice among farming community to use multiple risk management tools or a combination of risk reducing instruments simultaneously. For the present study two risk management alternatives are selected which forms four different combinations. 1) Use no risk management tool 2) use of diversification only 3) use of agricultural credit only and 4) use both diversification and agricultural credit. A farmer can choose only one of the four combinations. These combinations serve as basis for coding the dependent variable in the multinomial probit model. The parameter estimates of the multinomial probit model are presented in Table 3. The multinomial probit results provide information/inference that is different from the bivariate probit model because the focus is on factors affecting the combination of risk management tools that a producer chooses.

Except for farming experience in the diversification equation and access to Television for farm informa-tion in agricultural credit equation, the significant variables found in the bivariate probit model, also have significant effect on the adoption of combinations of the risk management tools in a multinomial probit analysis, which is indicative of the robustness of the results. The signs of the parameters are also fairly similar

Table 3. Parameter Estimates from Multinomial Probit Model

Independent Variables	Diversi-fication Only	Agricul-tural Credit Only	Both Diversi fication and Agricul-tural Credit
Farmer Characteristics			
Age	0.0503***	-0.0129	0.0431**
	(0.0193)	(0.0294)	(0.0207)
Education	0.0636**	0.0286	0.0876***
	(0.0301)	(0.0286)	(0.0307)
Experience	-0.0308	-0.0020	-0.0597**
	(0.0247)	(0.0342)	(0.0274)
Monthly Income	0.00007***	-0.0001***	0.00005**
	(0.00001)	(0.00003)	(0.00002)
Farm Size	-0.0993	0.0076	0.0694
	(0.0925)	(0.1057)	(0.1026)
Proportions of own land	0.0944	0.5887*	0.3886
	(0.2908)	(0.3455)	(0.3074)
Access to Information Sources			
Extension Worker	0.3104	2.1679***	1.7786***
	(0.3966)	(0.3890)	(0.3616)
Television	-0.4181	0.3031	0.2209
	(0.3535)	(0.3038)	(0.2687)
Radio	-0.2044	0.3038**	0.4805**
	(0.2507)	(0.2474)	(0.2257)
Newspaper	0.1496	0.3780	0.8391*
	(0.5443)	(0.5674)	(0.4917)
Private Consultant	-0.4368	-12.1912	-0.0201
	(0.6909)	(4.02e+07)	(0.6851)
Fellow Farmers	0.0349	-0.2570***	-0.0898
	(0.0703)	(0.0858)	(0.0719)
Relatives and Friends	-0.0187	-0.4259**	-0.3618**
	(0.1300)	(0.1781)	(0.1430)
Input Dealers	-0.9815***	-0.3722	-0.7277***
	(0.2224)	(0.2668)	(0.2221)
Log Likelihood Value		-322.6970	
Number of observations		330	

in both the approaches except for proportion of own land, access to Radio and private consultant in the adoption equation of diversification and proportion of own land in adoption equation of agricultural credit.

Significant variables in the adoption of combination 4 (the use of diversification and agricultural credit) are age, education and farming experience of the household head, monthly off-farm income of the household and variables associated with their access to Extension Workers, Radio, Newspaper, relatives and friends and input dealer. A general observation from the results indicates that access to formal sources of information encourages the use of both the risk management instruments at a time to manage risk associated with farm enterprise. These sources of information facilitate farmers to make rational production, investment and risk management decisions and should be prioritize in policies guiding agricultural sector, particularly those targeting agricultural risks.

Conclusion

The main conclusion drawn from the study is that farmers' decisions of adopting diversification and agricultural credit as risk management tools are correlated and adoption of one risk management tool may make it more likely to adopt the other tool at the same time. Moreover, access to information sources play a crucial role in farmers risk management adoption decisions and should be key elements in agricultural policies specially those targeting agricultural risks. When designing communication strategy for sharing agricultural information and knowledge, it is important to consider the available sources, channels and socio-economic status of farmers. Research on agricultural databases, information processing and communication systems is needed to be developed and implemented for enhancing extension services for the farmers. The lack of awareness regarding institutional lending in the study area is largely associated with farmers' lower level of education and lower access to formal information sources. To overcome this problem, agriculture departments should also arrange training programs for farmers, guiding them through the process of obtaining loan from institutional sources and encourage the positive use of the credit. Future work should look in to the role of information in farmers' decisions of adopting state owned Crop Loan Insurance Scheme (CLIS) and ways of overcoming information gaps that hinders farmers' access to these publically provided risk management strategies. Future research should also undertake an in-depth analysis of existing institutions at district, provincial and national level to provide policy prescriptions for institutional restructuring to bridge capacity and access gaps to overcome information lag for working under risky environment.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S.No	Author Name	Contribution to the paper
1.	Mr. Raza Ullah Khan	Concived the idea, Data Collection
2.	Ms. Mariam Rehman	Did SPSS Analysis, Data Collection, Result and Discussion,
3.	Ms. Maria Anjum	Wrote Abstract, Methodology,
4.	Mr. Muhammad Asif Kamran	Technical input at every step
5.	Mr. Khuda Bakhsh	Introduction, References
6.	Mr. Abdul Saboor	Overall management of the article

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