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PREDICTIVE MANAGEMENT COMPONENTS ON REDUCING THE RISK AVERSION COEFFICIENT: MAIZE FARMERS OF NORTHWESTERN IRAN

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Abstract

Increasing agricultural risks is a major challenge in economy and efficiency in the agricultural sector that affect income and production decisions of farmers and sometimes is a major obstacle in the sustainable development. Thus, the main purpose of study was to predict the management components in reducing the risk aversion coefficient (RAC) among maize farmers in Moghan plain (Iran). 278 farmers selected using multistage random sampling. RAC calculated through Safety First Rule model and predictive management components were determined by ordered logistic regression (OLR) by STATA software. Results revealed that the most of maize farmers (65.10%) were risk-averse. Also, results of OLR revealed that the probability of placing the farmers at higher levels of risk aversion increased significantly by increasing age, farming experience, farm input costs and facing with more agricultural risks; while increasing education level and farm income, better farm and technical infrastructure management and better risk-sharing management, the probability of placing the farmers at lower levels of risk aversion increased.

Key words: *maize farmers, risk management, risk aversion coefficient, Moghan plain*

INTRODUCTION

The maize (*Zea mays*) is one of the main and strategic products in northwest of Iran. More than 70 percent of the Iran country needed maize is provided in Moghan plain. Due to three important features (fertile soil, available water resources and suitable heat and moisture for agriculture), this plain always has been considered as one of the important pillars of agriculture in the country; but due to the new climatic changes and increasing occurrence of phenomena such as drought and reduction of water resources, nip and spread of pests and weeds, farmers facing with the phenomenon of risk as a major challenge in the region [17].

Risk is one of characteristics of agricultural. In this activity, a variety of natural, social, economic and public hazards lead to a fragile set for farmers that its final results are the threatened income, loss of productivity and reduction in the quantity and quality of their production. Thus, the farmers will be forced to make decisions about allocating resources to their agricultural production in facing with environmental conditions and different natural and unnatural risks; while they don't feel enough stability and confidence in environmental conditions, the status of inputs and outputs prices and their agronomic performance. Marginally, this influence farmers' agronomic decisions and under such circumstances, the results of farmers' decisions are different from the results in safer conditions. There are also different values of inputs consumption in condition of existence of agricultural risks and without risk and this values also depend on the other factors such as variance of the product price, the degree of risk aversion and the marginal share of inputs in production variance in addition to outputs and inputs prices and production levels [32]. In addition, farmers' decisions under risky terms can affect the productivity, farm income, using a variety of inputs, recommendations of agricultural experts, the marketing process and providing agricultural products and production price fluctuations and also may hinder the adoption of new technologies and agricultural sciences [15, 18]. Risk management is an important managerial activity of any operational unit with gaining awareness and understanding of the environment and sources of risk. It is actually one of the ways to increase productivity of production factors and to improve the efficiency of farming operation systems by making suitable decisions about controlling risk factors and resources. Therefore, the main strategy for facing with agricultural risks is the comprehensive utilization of risk management components in agriculture activities [22]. The risk resources of agricultural production are very broad and may include weather conditions (drought, flood, temperature changes, hail, wind, frost, tornadoes, earthquake, etc.), pests and diseases, weeds, soil conditions, production methods and financial and technical risks [2]. risks resources can be divided into four categories of economic, social, natural and market risks that this set of factors provide the conditions of vulnerability for farmers and its ultimate result is the instability of income for farmers. In other words, risk management involves the identification, assessment, evaluation, supervision and risk control and is consisted of a set of precautionary components, specific reactions and unorganized processes [18].

Olarinde et al. [18] studied the factors affecting risk aversion of farmers in the Savannah area (Nigeria) through econometric methods. In this study, maize farmers were divided into three groups based on attitude towards risk: low, medium and high risk-averse. Safety first rule model (SFR) was used to calculate RAC. The results showed that the majority of maize farmers (48.56%) were risk-averse but 42.53% were neutral and 8.91% were risk-taker. The most important factors effecting farmers' risk aversion were: age, household size, farm income, off-farm income, financial security for farmers, agricultural extension and education and business management.

Sulewski and Kłoczko-Gajewska [32] did a research regarding the risk perception, risk aversion and strategies for facing the production risk among Polish farmers. According to the results, the most important factor in increasing risk of farm productions was drought. Also, the majority of Polish farmers were risk-averse. Furthermore, the factors that lead to increased levels of agricultural risk aversion were consisted of the debts ratio, production wastes rate in recent years, soil quality and giving high priority to financial independence (improper management of risk-sharing). One of the most important strategies for facing risks among farmers was the crop insurance. Other findings showed that factors such as improved farmers understanding of sources of risk, reduction of the risk aversion level and implementing appropriate strategies to cope with risk consistent with the conditions and needs of farmers, were assumed as the main strategies for agricultural risk management.

Haneishi et al. [9] studied the attitudes of Ugandan rice and maize farmers about the production risk and its impact on agricultural productivity and decisions. findings revealed that most farmers were risk-averse and their attitude to risk affected their agricultural productivity. Age and religion were also effective in their attitudes; so that risk-averse farmers, by increasing land size, showed better agronomic performance and outputs than neutral-risk and risk-taker farmers respectively. The other results showed that age index has an inverse relationship with risk aversion attitude of farmers.

Akinola [5] Studied about risk preferences and strategies to cope with risk among Abeokuta farmers in Nigeria. results showed that most farmers (81%) had previous risk experience. The market risks (83%), production risks (69%), disease outbreak factors (63%) and political factors (61%) were the most important sources of risk among farmers. The factors which were positively and significantly effective in agricultural risk preference were age, education level, household size, cooperatives participation, credit access and income level. Thus, it was suggested that government efforts should be directed towards reducing production and market risks; enhancing farmers' participation in cooperatives and facilitating access to agricultural credit facilities to indirectly insure farms against risks.

Ullah et al. [33] studying factors affecting farmers' risk attitude and risk perceptions in Pakhtunkhwa (Pakistan), concluded that the majority of farmers were risk-averse. Variables of age, education of household head, off-farm income, land ownership status and access to informal credit sources, significantly affected farmers' attitude towards risk. The effect of socio-economic and demographic factors on risk-taker farmers were insignificant, while access to formal information and informal credit sources adds to the risk perception of farmers.

Gunduz et al. [8] studied the risk aversion degree and estimated the factors affecting risk aversion degree of apricot farmers in Turkey. results revealed that the mean RAC of farmers was 0.06 and most apricot producers in Malatya had the moderate level of risk aversion and the percentage of risk taking among the apricot producers was very low. Spring frost was the most important risk sources and monitoring the apricot market and sharing the market information with apricot farmers may decrease the market risk faced with apricot producers. OLR model was used to determine the effects of socio-economic variables and risk management strategies on RAC of farmers. Also, interestingly, farmers were not aware of the benefits of agricultural insurance. Furthermore, factors of education level, farming experience, household size, economics and marketing management, risk-sharing management and off-farm investment were effective in RAC of farmers.

Qasim and Ahmad [22] studied the agricultural risk sources and risk management strategies in the region of Pothwar of Punjab in Pakistan. In this study, exploratory factor analysis (EFA) was used. According to the findings, most farmers (50%) were risk-averse; 31 percent were risk-neutral and 19 percent were risk-taker. The most important sources of risk for farm households were inadequate extension services and rainfall shortage while crops, animal health problem and lack of farmers' cooperative were less important risk sources. In addition, the results showed that construction of small dams/turbine schemes, weather forecasting, off-farm income and production diversity are the most important risk management strategies applied by farm households. Also, Saqib et al. [27] in studying the effects of socio-economic factors on risk attitudes of farmers in flood-prone area of Pakistan, concluded that the majority of farmers were risk-averse in nature. The results for the logit model showed that education level, farming experience, landholding size and off-farm income significantly affect the risk attitude of farmers.

In sum, in this study, the effective components on reducing production risk among maize farmers were age [10, 21, 18, 32, 9, 24], education level [6, 11, 32, 9, 8, 24, 27], farming experience [10, 9, 8, 24, 27], household size [18, 32, 9, 8, 27], land size [16, 10, 21, 11, 19, 9, 24], maize yield [6, 10, 32], farm income [34, 10, 21, 18, 11, 19, 9, 22], off-farm income ([18, 32, 33], farm input costs [34, 9, 24], the number of agricultural machineries [10, 15, 18], the number of agricultural risks [18, 5, 24], planting management of maize [33, 24], growing management of maize [33, 24], harvesting management of maize [18, 33, 24], economics and marketing management [10, 18, 19, 32, 5, 33, 8, 24], farm and technical infrastructure management [18, 19, 5, 33, 24, 8, 22] and risk-sharing management [10, 5, 8, 22].

Most residents of Moghan plain in north of Ardabil province (northwest of Iran) are employed in agricultural jobs due to existence of suitable conditions for farming. The most important agricultural products in the region include maize (the most maize production in the country) wheat, barley, rice etc.; But with increasing range of production risk and the importance of the maize production in Moghan plain led to investigate and determine the predictive management components in reducing the coefficient risk aversion among maize farmers of Moghan plain in Iran.

MATERIALS AND METHODS

Area of study and sampling method

This study was an applied one based on descriptive-correlative method that was designed and implemented in 2016-2017. Area of study was Moghan plain located in north-western Iran. Moghan plain is in the northern part of Ardabil province, that shares borders in the north and east with Republic of Azerbaijan. Its maximum height above sea level is 500 meters and minimum of it is 40 meters (Fig 1). Moghan plain is considered as one of the important agricultural pillars in Iran for production of wheat, maize, barley, cotton and sugar beets.

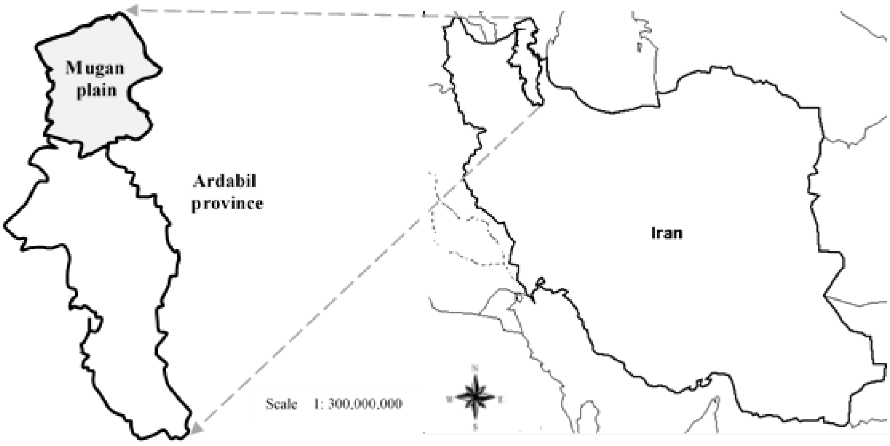

Fig 1. Area of study (Moghan plain, Ardabil province, Iran)
Source: Solgi et al. [29]

This plain contains 3 counties including Pars-Abad, Bileh-Savar and Germi covering an area of nearly 5245 Km^2. Given that most of the maize cultivation in the Moghan plain is limited to the Pars-Abad County (95% of the produced maize of the Moghan plain); so, the study population was consisted of all maize farmers of Pars-Abad County (915 farmers). This County is composed of three districts of Central, Aslan-Duz and Tazeh-Kand. Sampling method was multi-stage random. Applying the Yamane (1967) formula (equation 1), a sample size of 278 maize farmers in 9 villages was determined to be at a 95% confidence level with a ±5% margin of error [27]:

$$n= N/ (1+Ne^2) \quad (1)$$

where:
n = Sample size
N = Total number of maize farmers in an area
e= Precision value, set at ±5% (0.05)

The sample size consisted of 278 maize farmers in districts of Central (4 villages, 120 maize farmers), Aslan-Duz (3 villages, 95 maize farmers) and Tazeh-Kand (2 villages, 63 maize farmers).

The research instrument

The research instrument was a questionnaire including 69 items in three main sections i.e. personal and professional characteristics, RAC measurement and risk management components. Items of questionnaire consisted of the personal and professional characteristics of respondents such as age, farming experience, etc. in 18 items; variables of measurement of RAC such as subsistence income, expected income, etc. in 19 items and risk management components such as plant management of maize, growing management of maize, etc. in 32 items.

Risk management components consisted of sowing management of maize (suitable time of maize planting, use of agricultural drought-resistant varieties, etc. in 5 items), growing management of maize (suitable time of irrigation, appropriate use of fertilizers for increasing soil fertility, etc. in 5 items), harvesting management of maize (suitable time of maize harvest, appropriate use of harvest machines, etc. in 4 items), economics and marketing management (pre-sale of product, selling product to intermediaries, etc.

in 5 items), farm and technical infrastructure management (participation in extension and education, use of pressurized irrigation methods, etc. in 7 items) and the risk-sharing management (crop insurance, membership in agricultural organizations and cooperatives, etc. in 6 items). Items of risk management components with equal weights were collected by five-point Likert-type scale (1: very low to 5: very much). Given that some farmers were illiterate and some parts of the questionnaire included of detailed questions that need to be explained to the farmers, thus, some farmers were interviewed to complete each questionnaire. To determine the reliability of the questionnaire, first 30 questionnaires were distributed among farmers inside the statistical population, but outside of the sample size. The reliability of questionnaire was computed above 0.7 using Cronbach's Alpha and ordinal theta which represents the reliability of the research instrument. The face validity of the questionnaire was confirmed by a panel of experts including some faculty members of agriculture fields and a number of experts of Agriculture-Jihad organization in Moghan plain.

Calculation of RAC

To calculate RAC in maize farmers' decision-making, we used safety first rule (SFR). Randhir [23], Sekar and Ramasamy [28], Ajetomobi and Binuomote [3], Ajijola et al. [4], Sookhtanlo et al. [30], Onyemauwa et al. [19] and Akinola [5] used this equation (2) in their studies to determine farmers' risk-aversion degree. The basic premise of this rule is that the aim of the person is to minimize the possibility of a drop in income to a certain lower level. According to this rule, farmers select a technology and implement its certainty in the production of a specific crop while they feel comfortable and ensure that their subsistence needs are supplied [20, 19].

$$R\,i = [E^{*}i - E\,i] / [\delta\,i] \qquad (2)$$

where:
Ri: RAC of maize farmer
E * i: Disaster level of income
Ei: Expected income from the farm
- δi: The standard deviation of household income
- i = 1 to n
- n: Number of maize farmers (sample size).

The standard deviation of household income (δi) was obtained based on total approximate household income of farm and off-farm, during the recent three years' average. The cause of choosing an average of three years is to avoid cross standard deviation and reduce the likelihood of errors.

In the next step, two remain variables of disaster level of income (E*j) and expected income (Ej) should be estimated. Disaster level of income is given by Equation 3 ([19]):

$$E^{*} = (CN_{min} + CO) - (LA + NI) \qquad (3)$$

where:
CN_{min}: The minimum consumption needs of farmer' household that is calculated by equation (4).
CO: Credit outstanding, which include both institutional and non-institutional credit
LA: Liquid asset, which include farm and non-farm assets
NI: Non-farm income.

The minimum consumption needs of farmer' household (CN_{min}) is calculated as follows (equation 4):

$$CN_{min} = CA\,(HS - (CHI / 2)) \qquad (4)$$

where:
NC: Minimum number of calories per person
HS: Household size of farmer.
CHI: Number of children.

And marginally also, equation (5) is applied to calculate the expected income from the farm (Ei):

$$E = VF\,(1 + DMG) - TC \qquad (5)$$

where:
VF: Value of farm output (maize)
TC: Total Cost of farm inputs (maize)
DMG: weighted crop damage variable
DMG is given by Equation 6 ([26], [19]):

DMG = (Expected yield- Actual yield) / Expected yield (6)

RAC expressed above was regressed on the determinants of the risk aversion levels of the farmers.

Estimate of OLR model

Ordered logit models are used to estimate relationships between an ordinal dependent variable and a set of independent variables. The ordinal logistic regression model can be expressed as a latent variable model [1, 14]. So, Let "y_i" be the observed R_i value for the i^{th} respondent, $y_i = 1, 2, 3\ldots$, $i = 1, 2\ldots, N$. Given the discrete nature of y_i, we assume there is a latent variable (equation 7) [7, 36]:

$$y_i^* = \beta x_i + \sigma \varepsilon_i \quad (7)$$

where x_i is a row vector consisting of a constant term and K characteristics associated with respondent i,

β is a $K+1$ column vector of coefficients,

ε_i is an error term assumed to be logistically distributed with mean and variance ($\pi^2/3$), and

σ is a scale parameter.

The relationship between the observed R_i value, y_i, and its unobserved, latent value, y_i^*, is given by the following (equation 8) ([12], [13], [25], [31]):

$$\begin{aligned} y_i &= 1 \quad \text{if} \quad -\infty < y_i^*/\sigma < k_1/\sigma \\ y_i &= 2 \quad \text{if} \quad k_1/\sigma < y_i^*/\sigma < k_2/\sigma \\ y_i &= 3 \quad \text{if} \quad k_2/\sigma < y_i^*/\sigma < k_3/\sigma \\ y_i &= 4 \quad \text{if} \quad k_3/\sigma < y_i^*/\sigma < +\infty \end{aligned} \quad (8)$$

where k_j/σ are the "outpoints" that cause the observed value of the respondent's R_i to change in discrete units. The model above is known as the "OLR model [13, 36].

Given that the dependent variable of research (risk aversion levels of maize farmers) is an ordinal scale and of course shows different categories of RAC; therefore, to determine the most effective and predictive components on maize farmers' groups (grouped on the basis of risk aversion levels), the OLR model was used by STATA software.

In OLR model, the amount of Pseudo R^2 which is between 0 and 1, doesn't have the natural and usual interpretation of R^2 and in its interpretation we can only say that by increasing the amount of the model goodness of fit, its value increases [25]. In this model, the marginal effect or marginal probability is also calculated to obtain the effect of independent variables on the dependent variable's predicted probabilities or to choose the alternatives order. Also, due to the sum of the probabilities is always equal to 1, therefore, the sum of the marginal effects is equal to 0 for every variable. β coefficients are not directly relevant to marginal effects; so, we can calculate the marginal effects of variables in 4 levels of probabilities (risk aversion levels of maize farmers) using the following equations of 9, 10 and 11 [35, 36, 31]:

$$\frac{\sigma Prob\,(y=0 \mid x)}{\sigma Xi} = F\,(-x'\beta)\beta \quad (9)$$

$$\frac{\delta Prob\,(y=1 \mid x)}{\delta Xi} = [F(-x'\beta) - F\,(\mu_1 - x'\beta)] \quad (10)$$

$$\frac{\sigma Prob\,(y=\mathrm{j} \mid x)}{\sigma Xi} = F\,(\mu_{j-1} - x'\beta)\beta \quad (11)$$

According to the expressed points, previous studies and data results, research model is shown as below regression relationship:

$Y_i = \beta_0 + \beta_1 Age + \beta_2$ Education $+ \beta_3$ Experience $+ \beta_4$ Household $+ \beta_5$ Land$+ \beta_6$ Yield $+ \beta_7$ Income $+ \beta_8$ Offincome $+ \beta_9$ Cost $+ \beta_{10}$ Machinery $+ \beta_{11}$ N.risk $+ \beta_{12}$ M.planting $+ \beta_{13}$ M.grow $+ \beta_{14}$ M.harvest $+ \beta_{15}$ M.market $+ \beta_{16}$ M.infrast $+ \beta_{17}$ M.sharing

where: Yi: dependent variable of model (RAC)

So, considering Ri level is the ordinal outcome, y, ranging from 1 to 4, where 1= Risk-taker, 2 = Risk-neutral, 3= Low risk-averse and 4 = High risk-averse.

In indicated regression equation, the concept of listed items is as below:

Age: age (year); Education: education level (year); Experience: farming experience (years), Household: household size (person); Land: land size (hectare); Yield: maize yield (ton); Income: farm income (million rials);

Offincome: off-farm income (million rials); Cost: farm input costs (million rials); Machinery: the number of agricultural machines; N.risk: the number of agricultural risks; M. sowing: sowing management of maize; M.grow: growing management of maize; M.harvest: harvesting management of maize; M.market: economics and marketing management; M.infrast: farm and technical infrastructure management and M.sharing: risk-sharing management.

Totally, the independent variables entered into OLR, consisted of 17 main variables. Predictive components of different groups of farmers (on the basis of risk aversion levels) are obtained by ordered logistic analysis and calculating the marginal effects in STATA software.

RESULTS AND DISCUSSIONS

Demographic characteristics of respondents

The most frequency of farmers' age range (32%) was from 41 to 50 years. In terms of gender, 98.2% were male and 1.8% were female. most dominant education level was 4 to 6 years that were 41% of the sample. household size of most of the respondent (34.2%) was 5 people. In terms of land size, the most frequency of land size range, was 2.6 to 5 hectare (48.2%). The highest maize yield was between 11 to 15 tons per hectare (32.7%) and the most frequent farm income range (49.6%) was from 1,010 to 1,500 million rials; while the most frequent off-farm income was from 200 to 1,200 million rials (39.2%). Range of 260 to 1,000 million rials (34.9%) was the most dominant farm input costs among farmers. Majority of farmers (35.3 %) had ownership of three agricultural machines and the most of the farmers (40.6%) have faced between 3 and 5 agricultural risks. The other supplementary information is provided in Table 1.

Table 1. Statistical summarization of demographic characteristics among respondents

Variables	Mean	SD	Minimum	Maximum
Age (year)	46.1763	11.70769	25	74
Education level (year)	5.5288	2.60884	0	12
Farming experience (year)	21.9029	11.62538	5	50
Household size (person)	4.5396	1.20028	2	7
Land size (hectare)	5.0054	3.61167	0.5	30
Maize yield (ton)	17.0432	5.33177	5	36
Farm income (million rials)	2,627.42	970.24	645.83	5914
Off-farm income (million rials)	1,410.023	1028.391	50	3800
Farm input costs (million rials)	1,548.058	1028.391	100	4100
The number of agricultural machineries	3.5144	1.0008	1	5
The number of agricultural risks	4.9209	2.48334	2	13

Source: Own calculation.

Prioritization of risk management components among respondents

According to the table (2), for the research components, the first priorities were the suitable time of maize sowing (sowing management of maize); the suitable time of irrigation (growing management of maize); suitable time of maize harvest (harvesting management of maize); pre-sale of product (economics and marketing management); participation in extension and education programs of maize cultivation (farm and technical infrastructure management) and crop insurance (risk-sharing management).

Estimate OLR model

- Categorization of maize farmers into groups based on the RAC

Ordinal dependent variable for conducting OLR was RAC among maize farmers.

According to table 3, maize farmers with different RAC, categorized into four groups: code 1: risk-taker (15.1% of respondents); code 2: risk-neutral (19.8% of respondents); code 3: low risk-averse (37.4% of respondents) and code 4: high risk-averse (27.7% of respondents).

Table 2. Prioritization of items related to risk management criteria among the respondents

Risk management components	Items	Mean	SD	Rank
Sowing management of maize	- The suitable time of maize planting	2.752	1.192	1
	- Use of agricultural drought-resistant varieties	2.601	1.363	2
	- Use of improved seeds	2.255	1.179	3
	- Cultivating varieties with a short growing period	2.086	1.228	4
	- Use of disinfected and cleaned seeds	1.978	1.213	5
Growing management of maize	- The suitable time of irrigation	3.126	1.303	1
	- Appropriate use of fertilizers for increasing soil fertility	2.694	1.182	2
	- Appropriate use of herbicides	2.435	1.196	3
	- Appropriate use of pesticides	2.291	1.113	4
	- Appropriate control of weeds	2.022	1.222	5
Harvesting management of maize	- The suitable time of maize harvest	1.921	1.108	1
	- Appropriate use of harvesting machines	2.162	1.299	2
	- Use of skilled labor	2.507	1.130	3
	- Setting the harvesting equipment	2.896	1.091	4
Economics and marketing management	- Pre-sale of product	3.248	1.476	1
	- Selling crop to intermediaries	2.853	1.256	2
	- Selling crop to cooperatives	2.504	1.167	3
	- Access to formal credit	2.259	1.198	4
	- Access to informal credit	1.921	1.045	5
Farm and technical infrastructure management	- Participation in extension and education programs of maize cultivation	3.227	1.103	1
	- Use of pressurized irrigation methods	3.004	1.200	2
	- Contact with extension agents	3.000	1.546	3
	- Drainage of irrigated land under cultivation	2.935	1.485	4
	- Observance of crop rotation	2.827	1.198	5
	- Land leveling of the land under cultivation	2.813	1.159	6
	- Use of fallow	2.673	1.167	7
Risk-sharing management	- Crop insurance	3.223	1.085	1
	- Membership in agricultural organizations and cooperatives	3.155	1.184	2
	- Willing to grow maize in common lands	2.655	1.154	3
	- Willing to partner with others through their financial contribution in growing maize	2.612	1.327	4
	- Willing to partner with others through their workforce contribution for growing maize	2.543	1.244	5
	- Willing to partner with others through their agricultural machineries contribution for growing maize	2.162	1.268	6

Source: Own calculation.

Table 3. Categorization of maize farmers based on Ri levels

Codding	Range of risk aversion	Risk aversion class	Frequency	Percent	Cumulative Percent
1	$Ri < -10$	Risk-taker	42	15.1	15.1
2	$-10 \leq Ri < 0$	Risk-neutral	55	19.8	34.9
3	$0 \leq Ri < 10$	Low risk-averse	104	37.4	72.3
4	$Ri \geq 10$	High risk-averse	77	27.7	100.0
Total	-	-	278	100.0	-

Source: Own calculation.

According to initial regression model, 17 components entered the analysis for doing OLR, so that the main predictive components determined groups of maize farmers in terms of their RAC.

- Results of OLR model

According to Table 4, Log likelihood (-180.96913) and level of significance ($p < 0.001$) showed statistically significance of the regression model. Pseudo R^2 as a goodness of fit measure, shows a value of 0.5126.

Given that the level of significance and Z-statistic values for all components entered in the analysis, 7 of 17 components were significant at 1%, and only one component was significant at 5%. High pseudo R^2 measure the goodness of fit, combined with the 8 significant components at 1% and 5%, which indicated the model is desirable. In other words, predictive components consisted of age, education level, farming experience, farm income, farm input costs, the number of agricultural risks, farm and technical infrastructure management and risk-sharing management.

Components of age, farming experience, farm input costs and the number of agricultural risks had significant and positive effect on RAC of maize farmers; but components of education level, farm income, farm and technical infrastructure management and risk-sharing management had a significant and negative effect on RAC of maize farmers.

Table 4. Results of estimating OLR model

Dependent variables: Maize farmers' groups in terms of RAC (1- Risk-taker; 2- Risk-neutral; 3- Low risk-averse; 4- High risk-averse)						
Components	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
- Age	.1186016	.0168269	7.05**	0.000	.0856215	.1515817
- Education level	-.3147014	.0641758	-4.90**	0.000	-.4404836	-.1889192
- Farming experience	.0551569	.0149854	3.68**	0.000	.0257861	.0845277
- Household size	-.0023695	.1207222	-0.02	0.984	-.2389806	.2342416
- Land size	-.044631	.0439325	-1.02	0.310	-.130737	.041475
- Maize yield	-.033344	.0293146	-1.14	0.255	-.0907995	.0241114
- Farm income	-.0000628	.0000171	-3.67**	0.000	-.0000963	-.0000292
- Off-farm income	-.0002122	.0000133	-1.12	0.216	-.076450	-.0254321
- Farm input costs	.0003593	.000158	2.27*	0.023	.0000496	.0006691
- The number of agricultural machineries	.0640128	.1470662	0.44	0.663	-.2242316	.3522571
- The number of agricultural risks	.3499123	.0729115	4.80**	0.000	.2070083	.4928163
- Sowing management of maize	-.3656514	.2694839	-1.36	0.175	-.8938302	.1625273
- Growing management of maize	-.2816512	.2377433	-1.18	0.236	-.7476194	.1843170
- Harvesting management of maize	-.0137051	.2369253	-0.06	0.954	-.4780701	.4506599
- Economics and marketing management	-.3132176	.2577654	-2.26	0.294	-.8675098	.2145546
- Farm and technical infrastructure management	-.9314794	.1700532	-5.48**	0.001	-1.264778	-.5981812
- Risk-sharing management	-1.045945	.2257065	-4.63**	0.000	-1.488321	-.6035679
Log likelihood = -180.96913 LR chi^2 = 380.58			Pseudo R^2 = 0.5126 Number of obs= 278			Prob > chi^2 = 0.000

* P< 0.05; ** P< 0.01(2-tailed).
Source: Own calculation.

- The marginal effects' determination of the predictive components

To measure the effect of each component on dependent component of model, the marginal effects is calculated. The sum of marginal effects of each component for different levels of risk eversion (total levels) is equal to zero; because the sum of the probabilities for different levels of risk aversion is equal to one. Therefore, the amount of increase in probabilities of a level is equivalent to probabilities reduction in the level or other levels. Also, the amount of marginal effects of each component in each level of risk aversion represents probability of more or less the amount of component at each level of risk aversion (levels of 1,2,3,4) in comparison with other levels of risk aversion. According to the results presented in table 5, the amount of the marginal effects among components of age, farming experience, farm input costs and the number of agricultural risks in the first and second levels (risk-taker and risk-neutral) were negative; but in the third and fourth levels (low risk-averse and high risk-averse) were positive and had an increasing trend. In other words, increasing the mentioned components increases the probability of placing maize farmers in higher levels of risk aversion. But the marginal effects among components of education level, farm income and farm and technical infrastructure management in the first and second levels (risk-taker and risk-neutral) were positive; but in the third and fourth levels (low risk-averse and high risk-averse) were negative and had a decreasing trend. For risk-sharing management, the amount of the marginal risks in the first, second and third levels was positive; but for the fourth level (high risk-averse) was negative and had a decreasing trend. In other words, increasing the mentioned components, decreased the probability of placing maize farmers in higher levels of risk aversion. According to the marginal effects coefficients (Table 5), the highest marginal effects found in components of age (high risk-averse (0.2448)), education level (risk-taker (0.3456)), farming experience (high risk-averse (0.4939)), farm income (risk-taker (0.2504)), farm input costs (high risk-averse (0.4446)), the number of agricultural risks (high risk-averse (0.4855)), farm and technical infrastructure management (risk-taker (0.3437)) and risk-sharing management (risk-taker (0.1723)).

The marginal effects of each component indicates the amount of change in the predicted probabilities of dependent variable, per a unit of change in that component (if other factors remain fixed). For example, according to the marginal effects in table 5, per a unit of change in component of risk-sharing management, the probability of placing maize farmers in the first, the second and the third levels of risk eversion will be increased to 17.23%, 7.34% and 0.72%, respectively; but in the fourth level, it will be reduced to 25.30%. This results and provided interpretations can be seen in table 5, for the other components. Totally, according to marginal effects, the most important effective components were “farming experience” and the “number of agricultural risks”.

Table 5. Marginal effects of predictive components in the OLR model

Indexes	**Y=1**	**Y=2**	**Y=3**	**Y=4**
Constant	-	-	-	
Age	-0.2174	-0.1062	0.0788	0.2448
Education level	0.3456	0.1041	-0.0780	-0.3718
Farming experience	-0.4422	-0.1296	0.0779	0.4939
Farm income	0.2504	0.0541	-0.0344	-0.2701
Farm input costs	-0.2807	-0.1752	0.0112	0.4446
The number of agricultural risks	-0.3420	-0.15950	0.01600	0.4855
Farm and technical infrastructure management	0.3437	0.0827	-0.0790	-0.3474
Risk-sharing management	0.1723	0.0734	0.0072	-0.2530

Source: Own calculation.

CONCLUSIONS

Increasing the risk aversion among maize farmers and improper management of risk in long term, can have a negative impact in the economic, social and cultural conditions of farmers. Also, improper management of risk impacts affects farmers’ decision making in production and adoption of new technologies and it reduces the quantity and quality of the maize product [18, 33].

Therefore, determination of the predictive components on reduction of production risk among maize farmers can play a vital role in any plan for increasing production and income of farmers and reducing poverty and migration conditions; also, it increases the probability of adoption of required innovations and technologies for increasing farmers' production.

The results of calculating RAC (consistent with the findings of Ullah et al. [33] and Saqib et al. [27] showed that, majority of maize farmers were risk-averse (65.1%) and farmers with more RAC were facing with more agricultural risks.

Financial components of farm income and farm input costs also affected the farmers' risk aversion level. Due to t recent unprecedented droughts in the studied area maize farmers have faced different financial, environmental and psychological shocks while they didn't have enough experience and knowledge to manage drought risks.

Thus, seemingly, effects of this phenomenon has caused the majority of maize farmers to be more cautious and conservative in facing farm risks. Another important point is that, most maize farmers in the area are smallholder farmers (mean of farm lands size: 5.0054 hectares).

The smallholder farmers compared to other farmers, are very vulnerable to agricultural risks [10]; so this leads to increase risk aversion level of maize farmers in the Moghan plain. In this regard extension education courses related to drought risk management, strengthening supportive and governmental and non-governmental credits and facilities for maize crop and especially damaged farmers, providing the agricultural infrastructure programs including use of appropriate seeds for drought conditions and agricultural crops insurance can be recommended. Based on the research results and due to insignificance effect of risk-sharing management component, consistent with the findings of Akinola [5], and the marginal effects of this component and its prioritization results, it is suggested that efforts must shift to programs and politics that encourage farmers' cooperation. In this regard, local associations or farmers' organizations should be strengthened. Because of poor position of cooperative agricultural activities in the research area, it is necessary that initially the government take leadership role to promote programs but after developing common activities in maize production, the activities assigned to local associations or farmers' organizations. Encouraging farmers for membership in cooperatives and improvement of extension plans is proposed to accept the agricultural and drought insurance among farmers.

Furthermore, component of farm and technical infrastructure management (consistent with the findings of Olarinde et al. [18] has the power of differentiating farmers with different levels of risk aversion. According to marginal effects and results of prioritizing this component, it seems that technical assistance and credit support for applying pressurized irrigation methods and strengthening extension programs about optimal cultivation have a considerable impact in reducing production risk [8]. Since older, more experienced and less educated farmers have higher levels of risk aversion (consistent with the findings of Riwthong et al. [24]; it is suggested that visual and experiential extension methods such as "method demonstration", "result demonstration" and "field day" be applied for instruction of farm operations and risk management of maize production

Totally, the results of OLR model predict that older formers with more farming experience, more farm input costs and more agricultural risks, have more level of risk aversion. Higher level of education, more farm income, better farm and technical infrastructure management and better risk-sharing management, will increase probability of placing maize farmers in lower levels of risk aversion. Findings from this study could contribute to the development of a framework to address risks in agricultural activities. The implementation of such a framework will complement the various research and efforts hitherto aimed at increasing maize production, increasing smallholder farmers' income and alleviating their poverty in research area and similar regions.

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REFERENCES

[1]Agresti, A., 2002, Categorical Data Analysis, 2nd Edition. Wiley, New York, USA.
[2]Aimin, H., 2010, Uncertainty, risk aversion and risk management in agriculture. Agriculture and Agricultural Science Procedia, 1: 152-156
[3]Ajetomobi, J.O., Binuomote, S.O., 2006, Risk aversion among poultry egg producers in southwestern Nigeria. International Journal of Poultry Science, 6: 562-565.
[4]Ajijola, S., Egbetokun, O.A., Ogunbayo, I. E., 2011, Impact of risk attitudes on poverty level among rural farmers in Ogun State. Journal of Development and Agricultural Economics, 12: 581-587.
[5]Akinola, B. D., 2014, Risk Preferences and Coping Strategies among Poultry Farmers in Abeokuta Metropolis, Nigeria. Double Blind Peer Reviewed International Research Journal. Global Journals Inc., (USA), 5: 22-29.
[6]Davis, D., Patrick, G., 1999, What Influences Off-Farm Investments of Large Scale Producers? Journal of the ASFMRA, 15954: 23-29.
[7]Desalegn, M., 2011, Ordinal Logistic Regression Analysis of Correlates of Crime Severity: The case of Tigray Region, Ethiopia. Thesis of Science in Statistics. The School of Graduate Studies of Addis Ababa, department of statistics, Addis Ababa University, 1: 1-78.
[8]Gunduz, O., Ceyhan, V., Bayramoglu, Z. A., 2016, Determinants of farmers' risk aversion in taprico production in turkey. International Journal Management and Applied Science, 9: 149-155.
[9]Haneishi, Y., Maruyama, A., Takagaki, M., Kikuchi, M., 2014, Farmers' risk attitudes to influence the productivity and planting decision: A case of rice and maize cultivation in rural Uganda. African Journal of Agricultural and Resource Economics, 4: 309-322.
[10] Kahan, D., 2008, Managing risk in farming (Farm management extension guide (3)). Rome: Food and agriculture organization of the United Nations, FAO.
[11]Korir, L. K., 2011, Risk management among agricultural households and the role of off-farm investments in Uasin Gishu County. Thesis of Master of Science in Agricultural and Applied Economics, Egerton University, Kenya. Available on:http://ageconsearch.tind.io//bitstream/117806/2/Korir%20Thesis.pdf, Accessed on September 25, 2018.
[12]Liao, T. F., 1995, Testing Coefficient Equality and Adjusting for Dispersion Heterogeneity in Generalized Linear Models between Two or More Groups. Paper prepared for presentation at the annual meeting of the American Sociological Association, Washington DC.
[13]Liu, X., 2008, Fitting Proportional Odds Models to Educational Data in Ordinal Logistic Regression Using Stata, SAS and SPSS. Paper presented at the 2007 Annual Conference of the American Educational Research Association (AERA). Chicago, IL.
[14]Long, J. S., Freese, J., 2006, Models with Discrete Dependent Variables Using Stata. 2nd Edition, College Station, TX: Stata Corporation. 527 p.
[15]Mariconda, P. R., 2014, Technological risks, transgenic agriculture and alternatives. Scientist studies, Sao Paulo, 12: 75-104.
[16]Mishra, A.K., Morehart, M., 2001, Off-farm Investment of Farm Households: A logit Analysis. Agricultural Finance Review, 1: 87-101.
[17]Movahedi, M., Nouri Ghanbalani, G., Ranjbar Aghdam, H., Imani, S., 2014, Evaluating the Efficiency of Trichogramma pintoii and Bacillus thuringiensis Var. Kurstaki on Corn Stem Borer, Ostrinia nubilalis (Lepidoptera: Pyralidae), in Corn Fields of Moghan Plain. Bulletin of Environment, Pharmacology and Life Sciences Bull. Env. Pharmacol. Life Sci., 5: 202-205.
[18]Olarinde L. O., Manyong, V. M., Akintola, J. O., 2010, Factors influencing risk aversion among maize farmers in the Northern Guinea Savanna of Nigeria: Implications for sustainable crop development programs. Journal of Food, Agriculture & Environment, 1: 128-134.
[19]Onyemauwa, C.S., Orebiyi, J.S., Onyeagocha, S.U.O., Ehirim, N.C., Nwosu, F.O., Ben-Chendo, N.G., 2013, Risk Aversion among Farmers of the National Program for Food Security in Imo State Southeast Nigeria. Journal of Economics and Sustainable Development, 4: 131-138.
[20]Parikh, A., Bernard, A. 1988, Impact of risk on HYV adoption in Bangladesh, Agricultural Economics, Blackwell, October, 2:167-178.
[21]Pennings, J.M.E., Isengildina-Massa, O., Irwin, S.H., Garcia, P., Good, D, L., 2008, Producers Complex Risk Management Choices. Agribusiness, 1: 31–54.
[22]Qasim, M., Ahmad, N., 2016, Agricultural Risk Sources and Risk Management Strategies: The Case of Rain-fed Agriculture in Pothwar Region, Punjab, Pakistan. J. Appl. Environ. Biol. Sci., 3: 18-25.
[23] Randhir, O.T., 1991, Influence of risk on input decisions in Tank fed farms of South India. Indian Journal of Agricultural Economics, 46: 57-63.
[24]Riwthong, S., Schreinemachers, P., Grovermann, C., Berger, T., 2016, Agricultural commercialization: Risk perceptions, risk management and the role of pesticides in Thailand, Kasetsart Journal of Social Sciences, 1: 1-9.
[25]Saffari, S. E., Love, A., Fredrikson, M., Smedby, O., 2015, Regression models for analyzing radiological visual grading studies – an empirical comparison. BMC Medical Imaging, 49: 1-10.

[26]Salimonu, K. K., 2007, Attitude to Risk in Resource Allocation among Food Crop Farmers in Osun State, Nigeria. Unpublished PhD Thesis Submitted to the Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria.

[27]Saqib, S., Ahmad, M. M., Panezai, S., Ahmad Rana, I., 2016, An Empirical Assessment of Farmers' Risk Attitudes in Flood-Prone Areas of Pakistan, International Journal of Disaster Risk Reduction, 18: 107-114.

[28]Sekar, I., Ramasamy, C., 2001, Risk and resource analysis of rain fed tanks in South India. Journal of Social and Economic Development, 2: 208-215.

[29]Solgi, E., Sheikhzadeh, H., Solgi, M. (2018). Role of irrigation water, inorganic and organic fertilizers in soil and crop contamination by potentially hazardous elements in intensive farming systems: Case study from Moghan agro-industry, Iran. Journal of Geochemical Exploration, 185: 74–80.

[30]Sookhtanlou, M., Gholami, H., Es'haghi, S.R., 2013, Drought Risk Vulnerability Parameters among Wheat Farmers in Mashhad County, Iran. International Journal of Agricultural Management and Development (IJAMAD), 4: 227-236.

[31]Sookhtanlou, M., 2018, Inhibiting factors on adoption of pressurized irrigation methods according to drought zoning in North Western Iran (Ardabil province). DESERT, 23 (1): 45-55.

[32]Sulewski, P., Kłoczko-Gajewska A., 2014, Farmers' risk perception, risk aversion and strategies to cope with production risk: an empirical study from Poland, Studies in Agricultural Economics, 3: 140-14.

[33]Ullah, R., Shivakoti, G. P., Ali, G., 2015, Factors effecting farmers' risk attitude and risk perceptions: The case of Khyber Pakhtunkhwa, Pakistan. International Journal of Disaster Risk Reduction, 13: 151-157.

[34]Wencong, L., Aiqin, X., Jian, Y., 2006, Modeling Risk Behavior of Agricultural Production in Chinese Small Households. Poster paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August, 1: 12- 18.

[35]Williams, R., 2010, Fitting heterogeneous choice models with oglm. The Stata Journal, 4: 540–567.

[36]Xue, X., Reed, W. R., 2015, The relationship between social capital and health in china. Department of economics and finance, College of business and economics, University of Canterbury, Christchurch, New Zealand. Working paper, 5: 1-32.