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Knowledge, attitudes and risk management strategies among maize farmers in the Equatoria region of South Sudan

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Abstract

This study investigates risk perceptions and management strategies among maize growers in the equatorial region of South Sudan. A cross-sectional study design included a survey questionnaire that was used to analyse data from 510 respondents. Factor analysis was carried out to identify the risks and management strategies, while regression analysis was applied to determine factors influencing the perception of farms and farm characteristics. The results show that political unrest scored the highest perception among the sources of risks, pests and diseases, while the economic situation and limited technology transfer were the riskiest. The need for small dam schemes was the top priority among the perceived risk management issues, and off-farm income sources significantly influenced the management strategies. The regression results revealed that education substantially influences farmers' perceptions of risk sources. This study recommends educating maize growers in the form of training, particularly in relation to risk management. Credit facilities, technology transfers, machinery, seeds, opening up research centres and extension services, and an increased flow of information between government institutions and the public can minimise risks. This evidence *provides an opportunity not only for farmers, but also for the relevant policymakers, to realise the importance of risk management in enhancing maize production capacity.*

Key words: maize production, risk perceptions, management strategies, South Sudan

1. Introduction

The agricultural sector is the mainstay of South Sudan's economy and is the largest employer – for 60% to 80% of the working population. However, its potential has not been realised, especially among maize growers and despite the huge area of arable land (Museli 2017). On average, South Sudan has a population density of 18 people per km^2 (47 people per mi^2), and about five times more agricultural land per capita than other East African countries. However, many farmers mainly carry out their production on small plots of land with local tools, commonly known as hoes. As is the case in many other developing countries, the lack of storage facilities and pests such as weevils, rats and mice cause severe damage to the harvested crops. There also is limited labour and access to finance, as well as weather-related hazards. All of these continue to pose risks to farm activities (Ullah *et al*. 2016; Iqbal *et al*. 2020; Komarek *et al*. 2020).

Consequently, agriculture is a risky business that needs clear assessment and mitigation, as farmers constantly have to cope with and manage different risks (Komarek *et al*. 2020). While there are several ways to classify risks, the specific category is not essential. In agriculture, many types of risks can be identified, but they not limited to the following categories: Production risk is classified as uncertainties that arise in the production process, such as weather and climate variation, pests and diseases, soil metals, droughts, floods, etc. (Komarek *et al*. 2020). Market risks, on the other hand, look into uncertainties associated with the product's price, cost of equipment, market access and crop insurance, or input and output costs (Abate *et al*. 2015; Tadesse *et al*. 2015; Harčariková 2018). In contrast, institutional risks are related to institutions' policies that affect the national and legal environment of agriculture (Girdžiūtė 2012). In the case of finance, however, risks occur when money is borrowed to finance the farm business, and the yield determines the success of the service of the borrowed money. Human or personal risk refers to hazards associated with the farm business, caused by illness or accidents that can disrupt farm activities (Shonhe *et al*. 2022). Labour mobility and man-made risks such as civil wars have contributed to food shortages and given rise to food insecurity in many developing countries like South Sudan (Mugizi & Matsumoto 2021).

Researchers have shown interest in the impacts of risk in agriculture and uncovered many risk factors that affect farmers, and the ways in which they are handled (Aditto *et al*. 2012; Ullah *et al*. 2016; Komarek *et al*. 2020; Bang & Church-Burton 2021). Therefore, farmers employ traditional and modern risk management methods subdivided into preventive, mitigation and coping (before, during and after). Techniques include crop insurance, futures contracts, income diversification or off-farm investments, low-cost production, and preserving financial reserves (Hall *et al*. 2003; Ahsan & Roth 2011; Iqbal *et al*. 2020). It is crucial to understand that risk analysts typically assume a connection between the kind of risks and the management approach that should be used to control those risks. When farmers choose the optimal mix of risk management techniques and can implement them at the home level rather than the farm level, the risk management tactics are seen as acceptable (Wauters *et al*. 2014).

Nearly three decades ago, before the independence of South Sudan from Sudan, Sudan was a net exporter of agricultural products, including cereals (mainly maize and sorghum), to regional markets. However, South Sudan become a net importer of food as a result of war-related destruction, inadequate infrastructure and a lack of investment in the agriculture sector. Despite maize being the most significant cereal grain in South Sudan, as it is grown among communities in the equatorial region's green belt for food and as a source of income through the sale of surplus, its production does not have extensive coverage (Museli 2017).

Currently, South Sudan imports cereals mainly from Uganda and Kenya, and it also does so through assistance programme donations to fill the demand deficit (Dorosh *et al*. 2016). The African Development Bank recently signed off $14 million in funding to improve agricultural productivity (Malak 2021). However, South Sudan is far from realising its total output due to a number of factors posing risks to maize productivity and leading to severe food insecurity (Yami *et al*. 2020; Danis 2021). In comparison, maize is also a staple food that provides strategic food security within the East African bloc, i.e. Uganda, Kenya and Tanzania. The yield is gradually picking up, as these countries are also endowed with fertile and arable land in diverse climatic zones. A significant reasons for the yield picking up includes farmers minimising risks, especially maize farmers, who are using improved maize seed varieties, adopting new technology (machinery), investing in storage facilities, private investments, etc. (Teklewold *et al*. 2020).

Different maize varieties are also grown across the continent. For example, white maize is the most dominant and widely grown in South Africa, and has increased welfare benefits by up to more than $690 million in recent years (Ala-Kokko *et al*. 2021). Thus, one could suggest that South Sudan adopt such an approach. However, it is always challenging for policymakers at the country level to develop appropriate risk management strategies without understanding the situation at the grassroots level. Research has been carried out globally on the same subject matter (Ullah et al., 2016; Haro-Monteagudo *et al*. 2019; Iqbal *et al*. 2020; Rizwan *et al*. 2020b). Still, little has been done to ascertain the facts from the perspective of agricultural risk management, especially among farmers in South Sudan. Therefore, in line with the background, this study seeks to ask the following questions:

1. What is the risk profile in terms of the nature and extent of risks (and their sources) faced by Equatoria farmers?
2. What are the perceived strategies useful for risk management?
3. How is the perception of various risk sources and management strategies affected by different socioeconomic, demographic and geophysical features?

This study therefore seeks to find out more about the farmers' risk knowledge of, attitudes towards and perceptions of risk management strategies in relation to maize production.

The paper is divided into four sections: the first section has introduced the background to the study and highlighted the related literature; Section 2 describes the methodology; Section 3 presents the results and discussion; and Section 4 concludes.

2. Materials and methods

2.1 Selection of study area

This study makes use of both a qualitative and quantitative cross-sectional design involving a survey that was carried out in the three equatorial states of South Sudan, with the following coordinates: Eastern Equatoria, 04°45′N 33°11′E; Central Equatoria, 04°47′N 31°24′E; and Western Equatoria, 05°19′N 28°24′E (see Figure 1 and Table 1). One county (Payam) and two sub-counties (boma) from each state were selected for this study. These federal states share borders with Ethiopia to the east and Kenya to the south, the Democratic Republic of the Congo to the west, and Uganda to the north.

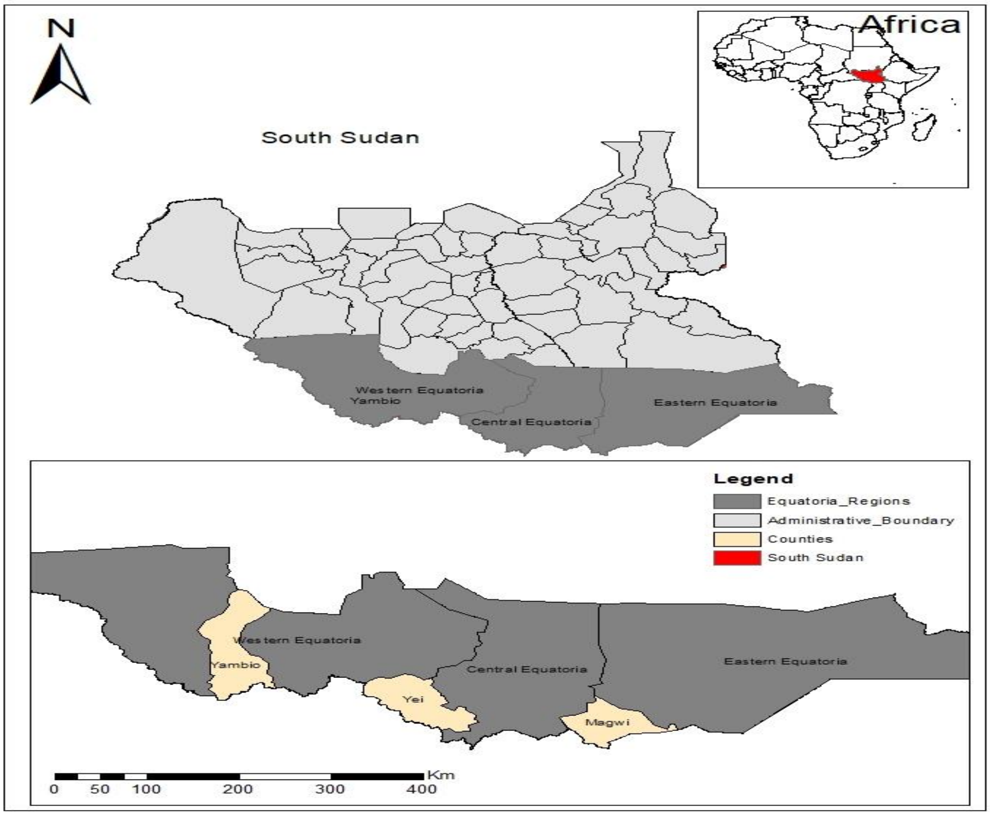

Figure 1: Geographical location of the study areas
Source: Created by the authors in ArcGIS version 10.61
Note: Dark grey indicates the Equatoria regions, grey shows the administrative boundaries, and dark yellow represents the selected counties.

2.2 Data collection and sampling

This study used a questionnaire for data collection because of its flexibility, as it gave respondents enough time to respond to the questions compared to other methods (Abawi 2017). The questionnaire was divided into two parts. Part A included questions that enquired about the social-economic indicators. The data captured in this section was measured in categorical variables (see Table 2). Part B captured questions about the risk sources, perception and management strategies, which were measured on a Likert scale.

Sampling refers to selecting statistically representative individuals from the population of interest that consists of too many individuals for a project that involves participants (Taherdoost 2018; Majid 2018).

Therefore, this study employed a non-probability sampling method, which refers to the process in which members' chances of being selected are unknown or unequal. Despite its generalisation and limitations, this sampling style is still valuable for gathering data, particularly for exploratory and qualitative research (Turner 2020). Purposive sampling was employed to deliberately select research participants to provide important information that cannot be obtained from other choices (Mohajan 2018; Taherdoost 2018). This sampling technique was selected because the researchers aimed their research at particular individuals with characteristics of interest to the study, thereby targeting respondents from different regions in the greater Equatoria. On the other hand, selecting subjects in this specific matter was advantageous and cost-effective, as the study was not funded.

Table 1 shows the number of selected counties in the greater Equatoria region of South Sudan

Table 1: Number of selected counties in the greater Equatoria region of South Sudan (N = 510)

States	Counties	Sub-counties	Sample size
Eastern Equatoria	Magwi County	Owinykibul	85
		Nimule	85
Central Equatoria	Yei County	Kaya	85
		Lainya	85
Western Equatoria	Yambio County	Nzara	85
		Naandi	85

Source: Compiled by authors

2.3 Research variables

Farmers' risks were used as variables. Risk can be understood as the product of hazard and vulnerability (Ullah *et al*. 2016) and is regarded as a damaging event, such as drought, severe weather conditions, and the foreseeable consequences of such an event. This study measured risks using a Likert scale of 1 to 5, ranging from high to low.

2.3.1 Dependent variables

This study regards risk sources and risk management strategies as dependent variables, which include production risks, natural risks, financial risks, technological risks, institutional risks, preventive management, mitigative management and coping management, etc., which are measured categorically, as follows: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree.

2.3.2 Independent variables

Farm and farmer factors, such as gender, marital status, level of education, family size, age, farm size, and source of off-farm income were the independent variables.

2.4 Data analysis

After collecting data, an Excel sheet was downloaded from Google Forms and coded before being imported into SPSS IBM version 25. All data were analysed to produce frequency tables and graphs, where necessary, to present the study's findings. Latent variables, which are thought of as dimensions in this study, reflect unobserved constructs. The structural equation modelling (SEM) method used was confirmatory factor analysis (CFA). However, it can also be used to discover method effects, validate constructs, evaluate psychometrics, assess measurement invariance and determine convergent validity. The common factor analysis method was applied to limit the number of factors containing the information. Validity and dependability can be established using CFA. This study deliberately employed CFA to improve its accuracy and rigour. A collection of observed continuous variables y (j = 1 to p) exhibited variation and covariation as a result of factors η (k = 1 to m) and residuals ε (j = 1 to p), according to the factor analysis model. For person I,

$$Yi1 = V1 + \lambda 11 \eta i1 + \lambda 12\, \eta i2 + \cdots + \lambda 1 \kappa \eta ik + \cdots \lambda 1 m \eta im + \varepsilon i1$$

$$Yij = Vj + \lambda j1 \eta i1 + \lambda j2\, \eta i2 + \cdots + \lambda j \kappa \eta ik + \cdots + \lambda jm \eta im + \varepsilon ij$$

$$Yip = Vp + \lambda p1 \eta i1 + \lambda p2\, \eta i2 + \cdots + \lambda p \kappa \eta ik + \cdots + \lambda pm \eta im + \varepsilon ip,$$

where Vj is the intercept, λjk is the factor loading, ηik are the factor values, and εij are the residuals, with zero means and zero correlations to the factors.

As a result, the model matrix has the following form:

$$Yi = V + \Lambda\eta i + \varepsilon i$$

Hence, V is the vector of intercept vj, Λ is the matrix of factor loading λjk, ψ is the matrix of factor variances/covariance, and Θ is the matrix of residual variances/covariance. The population covariance matrix of observed variables is Σ:

$$\Sigma = \Lambda\Psi\Lambda' + \Theta$$

In this example, the Heywood case is $\theta jj < 0$, the factor score is $\acute{\eta}1$, and the factor pattern and structure is $\Lambda{*}\Psi{*}$. The factor determinacy is the quality of factor scores with a correlation between ηi and $\acute{\eta} i$. The number of elements that have to be taken out was determined using the criterion (eigenvalue ≥ 1).

Risk sources and management techniques were categorised into different factors according to a rotated component matrix table or an orthogonal varimax rotation table. In addition, the model used each farmer's standardised factor ratings. Therefore, the Kaiser-Mayer-Olkin (KMO) score for risk sources was 0.752, while for risk management strategies it was 0.648. The correlation arrangement was compact, and the factor analysis was appropriate since both values were more than 0.60.

In the factor analysis technique, loading values higher than 0.30 were reflected as significant factors, while loading values higher than 0.40 were more significant (Ahsan & Roth 2011; Iqbal *et al*. 2020). The ordinary least square (OLS) regression model was employed for connotation among the farm and farmers' characteristics, risk sources, and risk management strategies. The ordinary least square (OLS) regression model was used to examine the features of the farm and the farmers, the sources of risk, and the correlation of the farmers' risk management techniques.

3. Results and discussion

3.1 Socio-demographic characteristics of the respondents

The results in Table 2 show the demographic characteristics of the respondents, with men comprising 70.8% (n = 354) and women constituting 29.2% (n = 146). The education level of the respondents shows that at least 32.6% (n = 162) had attained a secondary school education, 28.2% (n = 141) had enrolled in vocational institutions, and 23.8% (n = 119) had achieved a university or other higher institution of learning education. About 2.2% were illiterate. Regarding their age, 35.9% of the respondents were in the age range 30 to 39, 20.4% were in the range 20 to 29, 32.7% were 40 to 49 and 11.8% were older than 50. Considering that most of the respondents were relatively young, it will be risky not to engage the youth actively in agricultural production, which is crucial to bolster food security (Ouko *et al*. 2022). Most of the households were large, with 54.8% (n = 274) having a family size of six to 10 members, 40.2% (n = 201) of the respondents having e a family size of one to five members, and four households had a family size of 16 members (see Table 2).

Table 2: Demographic data of the respondents, including variable code (dummy and categorical)

Variables	Category	Variable code	*Measurement*	*F*	%
Gender of the respondent	Male	GN	1	354	70.8
	Female		2	146	29.2
Marital status of the respondent	Single	MS	1	112	22.4
	Married		2	320	64.0
	Divorced		3	4	0.8
	Widowed		4	34	6.8
	Separated		5	30	6.0
Education	Illiterate	EDU	1	11	2.2
	Primary		2	66	13.2
	Secondary		3	163	32.6
	Tertiary (Vocational institutes)		4	141	28.2
	University		5	119	23.8
Age	20-29	AG	1	107	21.4
	30-39		2	200	40.0
	40-49		3	167	33.4
	> 50		4	26	5.2
Family size	1-5	FS	1	201	40.2
	6-10		2	274	54.8
	11-15		3	21	4.2
	> 16		4	4	0.8
Off-farm	Agree	OF	1	157	31.4
	Strongly agree		2	333	66.6
	Neutral		3	7	1.4
	Disagree		4	1	0.2
	Strongly disagree		5	2	0.4
Risk-var-yield	Agree	RVY	1	151	30.2
	Strongly agree		2	234	46.8
	Neutral		3	59	11.8
	Disagree		4	37	7.4
	Strongly disagree		5	19	3.8
Risk-var-natural	Agree	RVN	1	127	25.4
	Strongly agree		2	331	66.2
	Neutral		3	24	4.8
	Disagree		4	13	2.6
	Strongly disagree		5	5	1.0
Risk-var-financial	Agree	RVF	1	160	32.0
	Strongly agree		2	398	79.6
	Neutral		3	17	3.4
	Disagree		4	12	2.4
	Strongly disagree		5	03	0.6
Risk-var-technology	Agree	RVT	1	137	27.4
	Strongly agree		2	291	58.2
	Neutral		3	39	7.8
	Disagree		4	24	4.8
	Strongly disagree		5	09	1.8
Risk-var-institutional	Agree	RVI	1	54	10.8
	Strongly agree		2	359	71.6
	Neutral		3	43	8.6
	Disagree		4	28	5.6
	Strongly disagree		5	16	3.2

Source: Compiled by authors

3.2 Results of risk sources

In the light of the farmers' responses, 33 potential risk factors were explored. These are illustrated in Table 3, with the mean and standard deviation of each risk source based on the farmers' evaluations (1 = agree, 2 = strongly agree, 3 = neutral, 4 = disagree, 5 = strongly disagree).

Table 3: Risk sources identified by farmers, with their mean and standard deviation, and ranking

Risk sources	Mean	Std. deviation	Ranking
Political unrest (civil wars)	2.67	1.23	1
Fire outbreaks	1.99	1.021	2
Exploitation by middlemen	1.9 5	0.973	3
Insufficient rainfall	1.86	0.947	4
Economic situation (such as inflation)	1.74	0.609	5
Excessive rainfall	1.74	0.575	6
Theft of agricultural produce from farms	1.73	0.735	7
Human health problems	1.7	0.621	8
Limited supply of NGOs credits	1.67	0.689	9
Inadequate extension services	1.67	0.756	10
Insufficient family labour	1.66	0.571	11
Transportation issues (poor road networks)	1.65	0.522	12
Severe weather conditions such as drought	1.65	0.758	13
Natural disasters	1.63	0.865	14
Lack of farmer cooperatives	1.62	0.648	15
High prices of inputs	1.61	0.66	16
Limited technological transfer	1.57	0.539	17
Inadequate research activities (low innovation)	1.54	0.556	18
Low price of maize	1.52	0.742	19
Lack of keeping farm records	1.52	0.599	20
Fluctuation in product prices	1.51	0.561	21
Lack of access to loan services by private companies or persons	1.5	0.572	22
Widespread of using traditional tools such as hoes	1.5	0.52	23
Uncertainty about the foreign market/international policy changes	1.49	0.628	24
Lack of guarantees and credit from buyers	1.46	0.57	25
High price of farm equipment	1.46	0.541	26
High wages of labour	1.45	0.593	27
Inadequate research activities (pests and diseases, such as maize weevil)	1.44	0.547	28
Limited supply of farm inputs	1.42	0.762	29
Lack of contract farming (companies, maize buyers)	1.4	0.719	30
Maize pests and diseases	1.38	0.7	31
Lack of access to loan services from the banks	1.38	0.551	32
Production risks/uncertainties	1.27	0.619	33

Source: Compiled by authors

Table 3 shows the different types of risks in descending order according to the respondents in the research areas. Political unrest or civil wars are rated as the highest source of risk. Research on the effect of conflict on agriculture due to the Boko Haram insurgency found a significant relationship between total output and productivity (Adelaja & George 2019). Similarly, Leonardo *et al*. (2020) identified the protracted displacement resulting from conflicts that has become the norm as another source of risk. They stress that refugees and internally displaced persons (IDPs) might spend decades in their new locations. When this happens, people abandon their croplands, which could have supported at least a quarter of the population (Olsen *et al*. 2021). Notably, humanitarian organisations have assisted millions of South Sudanese, in particular those affected by the conflict. d'Errico *et al*. (2020) found that those in higher-intensity conflict areas receive less assistance.

Insufficient rainfall and the economic situation are also important sources of risk, and this is particularly true for farmers in South Sudan, who rely on rain-fed weather. The standard deviation for the response to 'Insufficient rainfall and economic conditions' was less than 1, indicating that the respondents believed this to be true. On the other hand, poor transport networks and a lack of farmers' cooperatives were considered vital risk sources. In South Sudan, farming occurs in remote areas with poor road network development (Museli 2017). Accordingly, Adenle *et al*. (2017) identified infrastructure reliability as crucial in the movement of goods. At the same time, Howard *et al*. (2003) recommended infrastructure investment to ease transport costs. Other risk sources, with the mean values in parentheses, included human health problems (1.7), insufficient family labour (1.67), severe weather conditions such as drought (1.65), and widespread use of traditional tools such as hoes (1.5).

3.3 Risk source factor loadings

The factor loadings of the risk sources are presented in Table 4. A total of 33 risk sources were broken down into five variables using principal component extraction and factor analysis. The loading elements for each component have values larger than 0.40 in the square matrix, which is greater than 1. Values for Bartlett's test of sphericity were also noteworthy for being significant. The criteria were categorised as follows, ranging from 1 to 5: (a) production risks, (b) natural risks, (c) financial risks, (d) technology, and (e) institutional risks. Uncertainties relating to maize pests and diseases as they affect production have relatively high loading factors, implying higher yield risks. Factors such as the limited supply of farm inputs, and the lack of contract farming, are more significant in influencing risk sources. On the other hand, financial risk factors include lack of access to loans, high wages for labour, fluctuation of market price, etc. Technology factors include inadequate research activities, limited technology transfer, and widespread use of traditional tools such as hoes. Finally, institutional factors include uncertainty in the foreign market, political unrest (civil wars), the economic situation, inadequate extension services, etc.. These are also considered very crucial sources of risks.

Table 4: Risk sources (factor loadings)

Bartlett's sphericity test	**Approximate chi-square = 568443**				
Risks sources	**Factors**				
	1	**2**	**3**	**4**	**5**
Production risks/uncertainties	0.205	-0.293	0.169	-0.031	0.064
Maize pests and diseases	0.07	0.386	0.325	-0.348	**0.401**
Lack of contract farming (maize buyers).	0.287	-0.061	0.048	0.316	0.167
Limited supply of farm inputs	0.346	-0.033	0.093	-0.074	0.088
Excessive rainfall	-0.006	-0.113	-0.206	0.014	0.17
Insufficient rainfall	0.08	0.095	0.133	-0.115	-0.346
Severe weather conditions (drought)	0.006	0.113	0.24	-0.071	-0.207
Fire outbreaks	0.141	-0.151	**0.433**	0.006	0.124
Natural disasters	0.067	0.024	0.201	0.194	0.045
Lack of loan services from the banks	-0.077	0.029	-0.218	-0.108	-0.068
Lack of access to loan services from private companies or persons	-0.045	-0.23	-0.043	0.009	0.028
High price of farm equipment	0.007	0.072	0.103	0.031	-0.07
High wages of labour	-0.21	0.365	-0.014	0.213	**0.45**
Fluctuation in product prices	-0.169	0.231	-0.15	0.217	-0.065
Lack of guarantees and credit from buyers	-0.011	-0.138	-0.151	0.029	-0.316
Inadequate research activities (pests and diseases such as maize weevil)	-0.136	**0.452**	-0.057	-0.266	0.054
Inadequate research activities (innovation)	-0.275	0.034	-0.023	0.055	0.05
Lack of keeping farm records	-0.108	-0.197	0.065	-0.005	-0.23
Limited technological transfer	-0.126	-0.189	0.378	**0.475**	-0.002
Widespread of using traditional tools such as hoes	-0.12	-0.15	0.033	-0.194	-0.061

Uncertainty about the foreign market/international policy changes	-0.077	-0.192	-0.334	-0.12	0.335
Political unrest (civil wars)	-0.061	-0.034	0.211	0.076	-0.015
Limited supply of NGOs credits	**0.455**	0.042	-0.022	0.157	0.124
Economic situation (such as inflation)	-0.037	-0.099	0.11	0.121	0.1
Lack of farmer cooperatives	0.131	0.08	0.013	-0.367	-0.166
Inadequate extension services	0.104	0.052	-0.128	-0.247	0.013
Low price of maize	-0.093	0.048	0.08	0.291	0.083
High prices of inputs	0.058	-0.019	0.025	-0.147	0.075
Exploitation by middlemen	-0.171	0.177	0.033	0.172	0.033
Transportation (poor road networks)	0.1	0.051	-0.148	0.027	0.28
Theft of agricultural produce from farms	-0.124	-0.077	0.287	-0.035	-0.048
Human health problems	**0.434**	-0.078	-0.011	0.125	-0.108
Insufficient family labour	0.292	0.229	-0.224	0.084	-0.333
% of variance	3.889	3.684	3.331	3.288	3.124
Cumulative %	36.38	40.065	43.395	46.684	49.808

Source: Compiled by authors.
Note: Factor loadings above > 0.4 are highlighted. The factors from 1 to 5 are classified as production risks, natural risks, financial risks, technological risks and institutional risks, respectively.

3.4 Perceived risk sources, factor loadings, farms, and farmers' characteristics

Regression models were used to understand the relationship between farmers' characteristics, risk perception, and sources obtained from the factor loading. Notably, all models were significant. Table 5 shows the fitness of the regression coefficient, and some models found that the R^2 value was low. A previous study had similar findings (Flaten *et al*. 2005). Flaten *et al*. (2005) believe that the rationale for these differences is having different perceptions of risk sources. In this model, the state where the respondent lives shows a negative significance for all the dependent variables; this means that, wherever the location of the farmers, they experience the same risks because of having similar settings. Flaten *et al*. (2005) found in their study that institutional and production risks were perceived as primary sources of risk. Interestingly, this model agrees with many studies that have found that off-farm activities can be used to respond to unfavourable weather conditions, which lead to low production (Mathenge & Tschirley 2015; Rizwan *et al*. 2020a, 2020b).

Six variables, namely marital status, age, education, family size, state where the respondent lives, and the type of technology, are considered important production risks. In contrast, the gender of the respondents and the removal of the influence of intermediaries are considered to be less important. The education level of the respondents in this model is deemed significant in all the risk sources, as also stated in previous studies (Adnan *et al*. 2018; Rizwan *et al*. 2020a).

Table 5: Results of the regression between farm and farmer traits and risk source variables

Independent variables	**Production risks**	**Natural risks**	**Financial risks**	**Technological risks**	**Institutional risks**
(Constant)	1.245 (0.000)***	1.465 (0.000)***	1.358 (0.000)***	1.33 (0.000)***	1.301 (0.000)***
Gender of the respondent	-0.04 (0.315)	-0.006 (0.916)	-0.006 (0.862)	0.011 (0.731)	0.033 (0.317)
Marital status of the respondent	0.038 (0.082)*	-0.002 (0.956)	0.016 (0.366)	0.007 (0.697)	0.021 (0.244)
Age bracket of the respondent	0.07 (0.01)***	0.011 (0.788)	-0.033 (0.155)	-0.056 (0.014)***	-0.017 (0.467)
Education level of the respondent	0.016 (0.004)**	0.075 (0.006)***	0.027 (0.087)*	0.000 (0.007)**	0.026 (0.091)*
Family size of the respondent	0.144 (0.000)***	0.075 (0.134)	0.055 (0.055)**	0.102 (0.000)***	0.029 (0.319)

State where the respondent lives	-0.069 (0.001)***	-0.02 (0.514)	-0.053 (0.003)***	-0.028 (0.109)	-0.024 (0.181)
Removal of the influence of the middleman	-0.027 (0.171)	0.093 (0.001)***	0.000 (0.976)	0.029 (0.069)*	0.032 (0.055)**
Off-farm income sources	-0.004 (0.912)	0.000 (0.992)	0.011 (0.705)	0.032 (0.246)	0.064 (0.024)**
Farm tools	0.041 (0.000)***	-0.009 (0.54)	0.021 (0.014)**	0.021 (0.011)*	0.008 (0.367)
Adjusted R^2	0.93***	0.22***	0.32***	0.048***	0.24***

Source: Compiled by authors
Note: Variables are significant at * = $p < 0.10$, ** = $p < 0.05$, and *** = $p < 0.01$. **D**ummy variables are used: (1) where farmers indicate having off-farm income, indicated by 1, and 0 denotes otherwise; (2) where 1 indicates farmers who sell their product to agents or middlemen, and 0 denotes otherwise; (3) where 1 indicates farmers using traditional tools, and 0 denotes otherwise

3.5 Results of perceived risk management

Strategies for risk management were listed under 21 different factors, including sources of revenue from outside the farm, timely supply of farm inputs, removal of middlemen, use of risk management consulting, enough storage facilities, etc., as shown in Table 6 below.

Table 6: Farmers' perceived risk management techniques

Risk strategies	Mean	SD	Ranking
Small dams/turbine scheme	2.05	1.011	1
Removal of the influence of middleman	1.81	0.926	2
Off-farm income sources	1.72	0.54	3
Stock of spare parts	1.68	0.822	4
Timely supply of fertiliser to crop	1.64	0.665	5
Personal insurance	1.63	0.736	6
Contract farming to guarantee farm progress	1.61	0.618	7
Keeping debt low	1.6	0.69	8
Adopting new technologies	1.6	0.536	9
Providing training	1.6	0.559	10
Enough storage facilities to avoid post-harvest damage	1.58	0.59	11
Renting machinery at a low cost	1.58	0.649	12
Space diversification/planting in different areas	1.57	0.574	13
Improved marketing facilities	1.55	0.645	14
Own agricultural land (to avoid rent expenditure)	1.55	0.626	15
The use of risk management consultants	1.55	0.626	16
Pests, disease, price monitoring, etc.	1.55	0.655	17
Timely supply of inputs	1.54	0.67	18
Personal savings	1.48	0.65	19
Use of technical consulting	1.46	0.627	20
Preventing pests and diseases	1.35	0.57	21

Source: Compiled by authors

According to the risk management strategies in Table 6, farmers rated small dams/turbine schemes as an essential strategy. It is a fact that most South Sudanese farmers rely on the amount of rainfall received in a given season. On the other hand, South Sudan is among the countries most affected by climate change (UNDP 2017). Therefore, to minimise such risks, more schemes should be constructed to open up irrigation farming. Previous studies have found that small dam schemes are an important risk management strategy (Fowe *et al*. 2015; Iqbal *et al*. 2020; Rizwan *et al*. 2020b). Most farmers in South Sudan, particularly in the study areas, have limited financial outreach. Therefore, having an off-farm source of income helps them bridge the economic gap in the case of a surplus deficit from the harvest. Recent studies have made similar findings (Akhtar *et al*. 2019; Knapp *et al*. 2021).

Table 7 shows the factor loading for 21 perceived risk management strategies. Six factors were obtained with a significant Bartlett's value. Among these factors, providing training to the farmers and pest and disease price monitoring had the highest loading in factors 1 and 2. Bojnec and Krific (2021) found that diversification, such as off-farm sources, helps farmers to increase their investment capacity to improve production. In relation to factor 3, keeping debt low was considered the most significant risk management strategy, unlike factor 4, which had an average loading below 0.4. Furthermore, owning agricultural land to avoid rent expenditure, and providing training, had higher factor loadings in factors 5 and 6, respectively.

Table 7: Factor loading for risk management strategies

Bartlett's sphericity test	**Approx. chi-square = 56 083.418**					
Risk management strategies	**Factors**					
	1	**2**	**3**	**4**	**5**	**6**
Prevent pests and diseases	0.081	-0.299	0.05	-0.003	-0.188	-0.147
Timely supply of inputs	0.122	0.073	0.102	0.18	-0.356	0.038
Removal of the influence of the middleman	0.074	0.23	-0.047	0.333	-0.174	-0.133
Provide training	0.071	-0.054	-0.401	0.151	0.196	**0.47**
Adopt new technologies	0.111	0.052	-0.382	-0.041	0.005	0.249
Timely supply of feed to crop	0.109	0.122	0.015	0.421	-0.06	-0.042
Improved marketing facilities	0.14	-0.004	-0.079	0.227	-0.143	-0.051
Small dams/turbine scheme	0.091	0.237	0.021	0.013	0.332	-0.077
Pests, disease, price monitoring, etc.	0.133	**0.406**	-0.038	-0.026	-0.064	-0.054
Use of technical consulting	0.109	-0.373	0.081	0.099	0.047	-0.062
Space diversification/planting in different areas	0.11	0.061	-0.092	-0.35	0.107	-0.11
Personal insurance	0.13	0.061	-0.093	0.016	0.197	-0.25
Enough storage facilities to avoid post-harvest damage	0.129	-0.103	-0.305	-0.055	-0.104	-0.169
Own agricultural land (to avoid rent expenditure)	0.107	-0.094	0.098	-0.014	0.483	-0.297
Personal savings	0.118	-0.361	0.06	-0.085	0.059	0.098
Off-farm income sources	**0.493**	0.317	-0.031	-0.316	-0.058	-0.232
Keeping debt low	0.076	0.044	0.485	0.107	0.043	0.12
Stock of spare parts	0.097	0.101	0.258	0.13	0.332	0.336
Renting machinery at a low cost	0.104	0.09	0.13	-0.315	-0.113	0.47
The use of risk management consultants	0.109	0.014	0.142	-0.241	-0.254	0.03
Contract farming to guarantee your farm progress	0.129	-0.001	0.136	-0.122	-0.132	0.025
% of variance	19.253	7.419	5.817	5.663	5.417	5.041
Cumulative %	**19.253**	**26.672**	**32.489**	**38.153**	**43.57**	**48.61**

Source: Authors

Notes: Factor loadings > 0.40 are shown in bold. The three factors of risk management, namely prevention, mitigation and coping, are further divided into the following categories: obtaining capital and management, credit facilities, research and development, information management, insurance and diversification. These categories are denoted by the numbers 1, 2, 3, 4, 5 and 6, respectively.

Table 8: The effect of different variables on risk management strategies

Independent variables	Preventative management	Mitigative management	Coping management
(Constant)	0.541 (0.000)***	0.582 (0.000)***	0.463 (0.00)***
Gender of the respondent	0.02 (0.475)	-0.05 (0.141)	-0.015 (0.628)
Marital status of the respondent	0.031 (0.04)**	0.029 (0.129)	0.019 (0.254)
Age bracket of the respondent	-0.029 (0.135)	-0.043 (0.074)**	-0.043 (0.049)**
Education level of the respondent	0.01 (0.462)	0.015 (0.38)	-0.003 (0.836)
Family size of the respondent	0.037 (0.134)	0.042 (0.166)	0.061 (0.2)**
State where the respondent lives	0.008 (0.572)	-0.002 (0.899)	0.015 (0.369)
Removal of the influence of the middleman	0.168 (0.000)***	0.014 (0.409)	0.012 (0.446)
Off-farm income sources	0.063 (0.011)**	0.088 (0.004)***	0.17 (0.000)***
What kinds of tools are you using currently?	0.008 (0.255)	0.027 (0.003)***	0.008 (0.352)
Risk-var-yield	0.059 (0.087)**	0.087 (0.04)**	-0.021 (0.588)
Risk-var-natural	-0.001 (0.964)	0.035 (0.213)	0.01 (0.702)
Risk-var-financial	0.007 (0.008)**	0.049 (0.379)	0.153 (0.002)***
Risk-var-technology	0.155 (0.000)***	0.2 (0.000)***	0.033 (0.4963)
Risk-var-institutional	0.137 (0.002)***	0.096 (0.081)**	0.304 (0.000)***
Adjusted R^2	0.34 (0.000)***	0.16 (0.000)***	0.23 (0.000)***

Source: Author

Notes: Variables are significant at * = $p < 0.10$, ** = $p < 0.05$, and *** = $p < 0.01$. Dummy variables are used: (1) where farmers indicate having off-farm income, indicated by 1, and 0 denotes otherwise; (2) where 1 indicates farmers who sell their product to agents or middlemen, and 0 denotes otherwise; (3) where 1 indicates farmers using traditional tools, and 0 denotes otherwise.

The factors influencing farmer risk perceptions and mitigation techniques for maize growers were analysed using multilinear regression. There are three different models, viz., preventive management, mitigative management and coping management. Accordingly, marital status, removing the influence of intermediaries, off-farm income, risk variables of technology and institutions significantly affect preventive management. Married couples can advise each other and arrive at a concrete conclusion on the best risk prevention and mitigation method; previous studies have come to similar conclusions (Ahsan 2011). On the other hand, institutions can provide training, especially in preventing maize pests and diseases.

Remarkably, gender does not have a significant impact on preventive strategies. It implies that everyone can adopt agricultural technologies regardless of their difference. These findings agree with previous studies on this matter (Gebre *et al*. 2019; Glazebrook *et al*. 2020). Moreover, Gebre and Rahut (2021) stress that, if the same opportunities are given to male and female family heads, it will produce the same result. In addition, women are more likely than men to invest in the well-being of their families, especially in providing nutritious food and health (Ahsan & Roth 2011).

However, Glazebrook *et al*. (2020) found that investing in women needs more standard approaches; they stressed that capital and technology, effective execution of policy, governance and education should be given to both men and women. Furthermore, education, age, family size, risk variables of technology and institutions significantly affect risk-mitigation measures. Through education, maize farmers can easily adopt risk-mitigation measures, and a concrete decision can be taken (Rizwan *et al*. 2020a). Age, education, family size and risk variables in finance and institutions significantly affect coping strategies. It is imperative to know that financial institutions such as credit facilities can lend financial support to maize farmers so that they can invest in their farming activities.

Peng *et al*. (2020) found that lacking funds hinders risk management. Adults are believed to have more experience in agricultural risk management; in addition, the possibility of farmers modifying their agricultural production is boosted considerably by the age of smallholder farmers (Peng *et al*., 2020). A study conducted among cotton farmers in Punjab, Pakistan revealed that age, experience and education had a significant effect on risk perception and attitude (Iqbal *et al*. 2016).

3.6 Limitations of the study

The researcher employed a purposive sampling method targeting specific population strata; however, because of the country's instability, some potentially targeted groups had been forced to leave for safety as refugees in neighbouring countries, especially in Magwi County. Further studies should cover other regions so that farmers and policymakers can understand those areas better

4. Conclusions and recommendations

The lack of knowledge of risk management is pervasive and deeply rooted in the study area, as well as in similar risky environments in South Sudan, and has increased food insecurity. There is widespread ecological fragility, along with underlying socio-economic vulnerability. Males are considerably more dominant in maize production compared to females. Political unrest also scored the highest perception as a source of risk among the respondents. Maize pests and diseases, the economic situation, limited technology transfer and other issues had a higher factor loading, as education is geared towards other fields, not agriculture. The regression results show that education has significantly influenced the perception of all risk sources. The management strategies and risk variables of financial and technology risk management strategies were perceived as being the most important. Since producers have diverse perspectives on risk management methods that are more significant, it is hypothesised that adopting universal risk management solutions will be less successful. This study also recommends educating farmers through training on best practices to be aware of risks associated with maize production so as to prevent, mitigate and recover if any hazards hit them during the production cycle. There is a need to provide credit facilities for farmers at a low interest rate, and even for capacity-building programmes. Lastly, drought-resistant seeds need to be provided to the potential farmers, either for free or as loans payable after production.

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