THE ROLE OF RISK PERCEPTIONS AND RISK ATTITUDES ON HEDGING DECISIONS: EVIDENCE FROM COFFEE FARMERS

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ABSTRACT

The purpose of this work is to investigate the factors influencing the adoption of price risk management tools by coffee farmers. The study also explores the risk perceptions of coffee farmers towards the severity degree of risk events. Results are based on primary data obtained from a sample of 385 coffee farmers. Findings indicated that the three most important risk events with greater severity perception are input and coffee price fluctuations and drought. Using multinomial regression models, we found evidence that risk aversion plays an important role in the decision to use risk management tools. The characteristics of the farm – size, mechanization, and leverage – also influence the adoption of price risk mitigation strategies.

Keywords: risk perception, risk management, risk events.

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INTRODUCTION

Agricultural activity is characterized by the existence of multiple and severe risks. These risks range from production, price, credit, farming operations, institutional environment, and other factors. The incidence of risk events has the potential to disrupt supply chains, leading to financial losses for market agents. This is particularly relevant in coffee production as coffee is typically grown by smallholder farmers in lower-income and highly agriculture-dependent countries (Silveira et al., 2017). Thus, the incidence and severity of certain risk factors can affect the economic growth of these countries, with implications for poverty and food security. The analysis of the frequency in which risk events occur and the severity of their impact gives a list of key priority events, which helps to guide the adoption of risk management strategies.

Price risk is particularly relevant in the coffee sector. In general, a coffee grove has a lifespan of around 30 years (maintaining good productivity indices), with the first harvest only being obtained after the third year of the plantation. Due to the low price elasticity of demand and supply in the short run, the coffee market is characterized by large price variability, which can significantly affect the viability of the business. For instance, droughts and high or low temperatures in a growing area can damage coffee trees, as well as affect the coffee quality and, consequently, the profitability of production.

On the other hand, as demand is inelastic in the short run, supply shortage leads to a sharp increase in prices. Nevertheless, in the long run, both demand and supply are more elastic. High market prices will stimulate the expansion of planting area, resulting in supply growth after approximately three to four years, when coffee trees reach maturity. As a result, the supply shortage is likely to turn into oversupply after a few years, leading to a decrease in prices and the beginning of a new cycle of low prices, “usually lasting longer than the boom period” (Ponte, 2002, p. 1104). If prices drop below direct costs, some producers would consider abandoning their crops, which has the potential to lead to higher prices.

The sharp fluctuations in coffee prices highlight the importance of the adoption of strategies to mitigate price risk. In general, these strategies include forward and futures

contracting, spreading sales, off-farm income, and crop diversification (OECD, 2009). Recent studies have investigated the determinants of the adoption of risk management tools, exploring how farmers and business characteristics influence this decision (Kyire et al., 2023; Nainggolan et al., 2023; Adhikari and Aditya, 2021; Meraner and Finger, 2019; Carrer et al., 2019).

In this context, the purpose of this work is to investigate the factors that influence the adoption of price risk management tools by coffee farmers. In addition, the study examines the risk perceptions of coffee farmers and assesses their perception of the severity of risk events.

This study presents empirical evidence that contributes to the debate on the use of risk management strategies in agricultural activity. Price analysis is critical for this market as price movements can influence trading strategies, marketing, and risk management. This assessment is relevant in the face of increasing climate uncertainty, which has the potential to directly impact price volatility. Findings from this research provide useful insights for policymakers in designing new risk management instruments and refining the existing strategies to contribute to greater stabilization of farmers' income.

RESEARCH METHOD

The empirical analysis of this study is carried out in two steps. The first one is based on the assessment of coffee farmers' risk perception. The second step examines the factors that influence the adoption of price risk management tools by coffee farmers.

To calculate the risk perceptions, coffee farmers were asked about the frequency of 18 risk events[1] and their financial impact on the activity. For this purpose, a Likert scale was used ranging from 1 (low degree) to 3 (high degree), resulting in a severity degree that ranges between 1 to 9 points – equation (1).

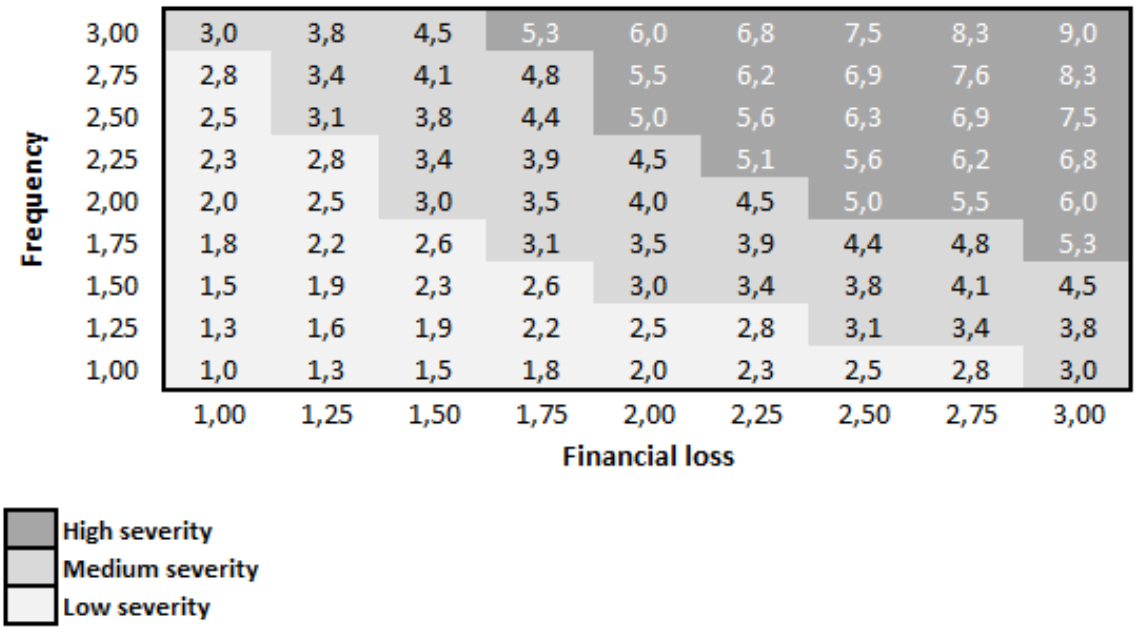
$$\text{Severity degree} = \text{Event frequency} \times \text{Financial loss} \quad (1)$$

Based on the farmers' responses, the risk events were ordered according to their severity degree. The scores were also plotted in a severity matrix with two-dimensional data

[1] Drought, hail, pest, wind, frost, plant diseases, fluctuating coffee prices, fluctuating input prices, insufficient credit, increased guarantees for obtaining credit, farmer management problems, lack of skilled labor, difficulty accessing technical assistance, strikes and road/port interruptions, inadequate water/soil/input management, inadequate storage, changes in the rigor of classification standards, and water contamination.

(frequency and financial loss). A score between 1 and 2.9 was categorized as low, while 3 to 4.9 was considered medium and 5 to 9 high – Figure 1. In addition, nonparametric Mann-Whitney U tests were applied to investigate if the median of the severity degree of an event was statistically different from the median of another event.

Figure 1. Risk matrix



To evaluate the factors influencing farmers' risk management adoption, multinomial probit regression models were used – equation (2) (Tudor et al., 2014; Velandia et al., 2009). The dependent variable was based on the use of risk management strategies. In our model, we considered three possible tools: forward contracting, barter operations, and crop diversification. Thus, there are eight possible strategies: (1) no adoption – the farmer did not use any of the three strategies, (2) use forward contracting only, (3) use barter operation[2] only, (4) use crop diversification only, (5) use forward contracting and barter, (6) use forward contracting and crop diversification, (7) use barter and crop diversification, and (8) adopt all three tools simultaneously.

$$Y_i = x_i'\beta + \varepsilon_i, \qquad \varepsilon_i \simeq MVN(0, \Sigma) \tag{2}$$

[2] Acoording to Saes et al. (2019), a barter operation involves two steps: "i) the farmer purchases inputs from agroindustries before planting, and, as a form of payment, agrees to provide part of his production to a trading company (…); ii) after the harvest, the producer delivers the grain to the tradings, which is commercialized as a commodity and used to pay the input company".

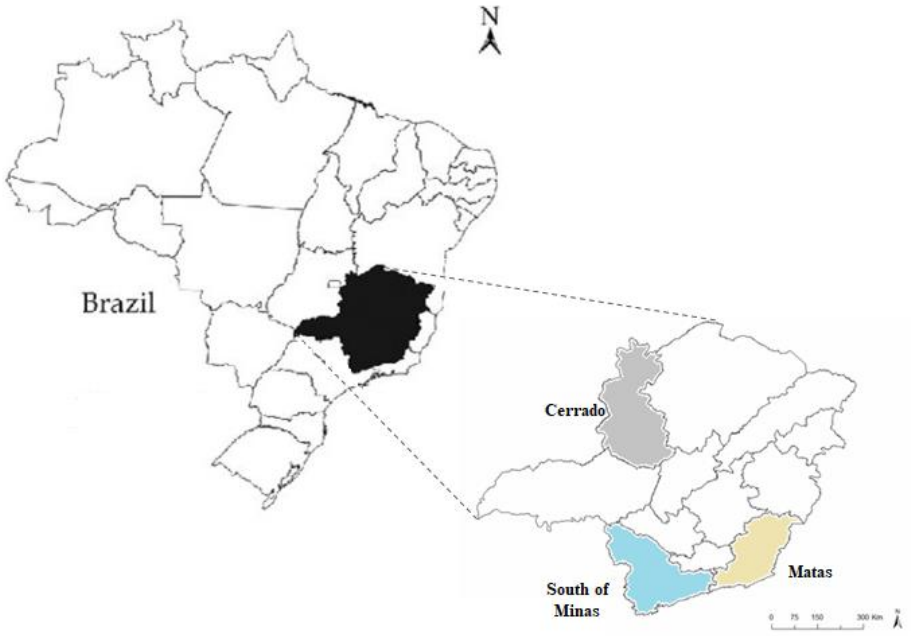
Where Y_i (j = 1, …, 8) consists of the risk management strategy adopted by the ith farmer (i = 1, …, n). Explanatory variables ($\boldsymbol{x_i}$) are grouped into three categories: producer characteristics (i.e., education level and experience), farming characteristics (i.e. location, area size, financial leverage, and technology adoption), and farmers' risk perceptions and risk attitudes (i.e. price risk perception, climate risk perception, and risk aversion). β is a vector of coefficients, which shows the impact of changes in the explanatory variables ($\boldsymbol{x_i}$) on the probability of adopting hedging strategies relative to the base scenario (no adoption), and ε_i is the unobserved error term. The parameters of equation (2) are estimated by maximum likelihood.

DATA

Data were collected from in-person interviews with 385 coffee farmers (randomly selected) between February and May 2023[3]. The sample covered the main three coffee-producing regions in Brazil (South of Minas, Cerrado, and Matas), located in the state of Minas Gerais – Figure 2. The questionnaire consisted of questions regarding the farmer's characteristics and their businesses, as well as their risk perceptions and attitudes. In addition, we assessed whether farmers have adopted risk-coping strategies, identifying the instruments used.

[3] The project was approved by the Research Ethics Committee (Project Number: 65824622.6.0000.8142).

Figure 2. Area of the study.



The descriptive statistics of the variables used in the study are presented in Table 2. From the sample of 385 producers, around 33% used forward contracts to manage coffee price risk (126 farmers), 15% adopted barter operations (57 farmers), and 41% presented crop diversification (157 producers). In addition, Table 3 shows the proportions of farmers using different combinations of risk management strategies. A group of 142 farmers did not use any risk management tools (37% of the sample). On the other hand, 162 farmers adopted only one tool (42%) and 81 farmers used combined strategies (21%).

Table 2 also shows that farmers generally have a high level of experience in coffee farming (24 years on average), and 22% of the sample presented a college degree. Most of the farmers showed a high-risk aversion and high-risk price perception. In addition, 80% of the farms were mechanized, and 54% were financed by loans.

Table 2. Descriptive statistics of the collected variables.

Variables	Description	Mean	Std. Dev.
A. Dependent variables			
Forward contracting	*Dummy* variable that assumes a value equal to 1 if the farmer uses forward contracts, and 0 otherwise.	0.32	0.47
Barter operations	*Dummy* variable that assumes a value equal to 1 if the farmer uses forward contracts, and 0 otherwise.	0.15	0.36
Crop diversification	*Dummy* variable that assumes a value equal to 1 if the farmer adopts crop diversification, and 0 otherwise.	0.40	0.49
B. Independent variables			
Experience	Years of experience in coffee farming	24.73	15.14
Educational level	*Dummy* variable that assumes a value equal to 1 if the farmer has a college degree, and 0 otherwise	0.22	0.41
Leverage	*Dummy* variable that assumes a value equal to 1 if the activity has loans in banks to finance the coffee activity, and 0 otherwise	0.54	0.50
Mechanization	*Dummy* variable that assumes a value equal to 1 if the farm is mechanized, and 0 otherwise	0.80	0.40
Log(Size)	The logarithm of the total area of the farm	2.51	0.67
Cerrado Region	*Dummy* variable that assumes a value equal to 1 if the farm is located in the Cerrado region, and 0 otherwise	0.53	0,50
Matas Region	*Dummy* variable that assumes a value equal to 1 if the farm is located in the Zona da Mata region, and 0 otherwise	0.15	0,36
Risk aversion [a]	*Dummy* variable that assumes a value equal to 1 if the farmer has a high degree of risk aversion, and 0 otherwise	0.81	0.39
Coffee price risk perception [b]	*Dummy* variable that assumes a value equal to 1 if the farmer presented high coffee price risk perception, and 0 otherwise	0.75	0.43
Input price risk perception [b]	*Dummy* variable that assumes a value equal to 1 if the farmer presented high input price risk perception, and 0 otherwise	0.67	0.47
Drought risk perception [b]	*Dummy* variable that assumes a value equal to 1 if the farmer presented high drought risk perception, and 0 otherwise	0.44	0.50

Notes:

[a] The variable risk perception was obtained using a three-point Likert scale (1- represented complete disagreement and 3 complete agreement). The farmer selected their degree of agreement with the statement: "When conducting my business, I prefer the certain to the uncertain".

[b] These variables were obtained in the first step of the methodology, in which coffee farmers indicated the severity of risk events. The severity degree was calculated by multiplying the perception of the farmer about the frequency and the financial impact caused by the event. To compute these perceptions, we use a Likert scale, that ranges from 1 (low degree) to 3 (high degree). Thus, the severity degree ranges between 1 to 9 points, in which levels 5 to 9 were considered high.

Table 3. Number of farmers using different combinations of risk management tools.

Group	Risk tool combination	Number of farmers	Proportion (%)
1	No adoption	142	36.88%
2	Only forward contracting	50	12.99%
3	Only barter operation	10	2.60%
4	Only crop diversification	102	26.49%
5	Forward contracting and barter	27	7.01%
6	Forward contracting and crop diversification	34	8.83%
7	Barter and crop diversification	5	1.30%
8	Forward contracting, barter, and crop diversification	15	3.90%
	Total	**385**	**100.00%**

RESULTS

Table 4 shows the severity degree considering the farmers' perception of the frequency and financial loss of the risk events. In addition, Figure 3 shows risk events, grouping them into high, medium, and low levels of severity. The three most important risk events were input price fluctuation, coffee price fluctuation, and drought.

The nonparametric Mann-Whitney U test was applied (Appendix 1), focusing on the eight most relevant risk events (high and medium risk levels) to the other events. Findings indicate two groups of events of greater relevance. The first one comprises the input and coffee price fluctuations and drought, while the second one includes lack/disqualification of the workforce, plague, and plant diseases.

The findings reflect a recent market scenario characterized by strong price fluctuations, both in coffee and in inputs. During the 2020-2023 period, coffee prices oscillated between 86 USD/Lbs and 253 USD/Lbs. In addition, the Russia-Ukraine conflict has led to a sharp increase in the price of fertilizers, which accounts for around 35% of the operating cost of the activity. Another important point refers to the rising temperature and water deficit that the farmers have been facing in recent years in the area of the study. Every year during the period between 2020 and 2023, coffee farmers have faced a water deficit. Consequently, considering the climate risk events, drought was indicated as the most relevant risk.

Table 4. Farmers' severity perception.

Code	Risk events	Type of risk	Average	Median	SD
A.	Input price fluctuation	Price	7.4	9.0	2.4
B.	Coffee price fluctuation	Price	7.1	9.0	2.5
C.	Drought	Production	5.7	6.0	2.9
D.	Lack/Disqualification of the workforce	Operational	4.4	4.0	3.5
E.	Plague	Production	4.2	4.0	3.1
F.	Plant diseases	Production	4.1	4.0	3.1
G.	Frost	Production	3.5	3.0	3.3
H.	Hail	Production	3.5	3.0	3.1
I.	Increase in guarantees for obtaining credit	Credit	2.8	2.0	3.0
J.	Change in the rigor of classification standards	Institutional	2.7	2.0	2.8
K.	Credit insufficiency	Credit	2.4	1.0	2.7
L.	Wind	Production	2.2	1.0	2.5
M.	Difficulty in accessing technical assistance	Operational	2.1	1.0	2.6
N.	Farm management issues	Operational	1.8	1.0	2.1
O.	Strikes and interruptions of highways/airports	Institutional	1.7	1.0	2.0
P.	Inadequate soil/water/input management	Operational	1.7	1.0	1.9
Q.	Inadequacy of storage	Operational	1.6	1.0	1.6
R.	Water contamination	Production	1.4	1.0	1.3

Figure 3. Risk event matrix results.

Note. A. Input price fluctuation, B. Coffee price fluctuation; C. Drought, D. Lack/Disqualification of the workforce, E. Prague, F. Plant diseases, G. Frost, H. Hail, I. Increase in guarantees for obtaining credit, J. Change in the rigor of classification standards, K. Credit insufficiency, L. Wind, M. Difficulty in accessing technical assistance, N. Farm management issues, O. Strikes and interruptions of highways/airports, P. Inadequate soil/water/input management, Q. Inadequacy of storage, R. Water contamination.

Table 5 presents the estimated coefficients of the univariate probit model. In Model I, the dependent variable is the use of forward contracting, while Models II and III consider the adoption of the other two tools (barter and crop diversification). In general, findings indicate that the area, mechanization, and leverage have a positive influence on the use of forward contracting and barter (Models I and II). In addition, coffee growers who present higher experience and higher price risk perception tend to use forward contracts.

On the other hand, the negative and significant parameter estimate on the Cerrado region variable shows a lower likelihood of using barter operations in this region relative to the omitted region (South Minas). Moreover, farmers who show lower drought risk perception tend to use crop diversification.

Table 5. Parameter estimates from the univariate probit regression model for estimating the factors influencing the adoption of agricultural price risk management tools.

Variable	Model I (Forward)	Model II (Barter)	Model III (Diversification)
Intercept	-0.3247**	-0.1275	0.4841***
log(Experience)	0.0718**	0.0271	-0.0289
Education	0.0082	-0.0024	0.0117
Leverage	0.1708***	0.0788**	-0.0730
Mechanization	0.1314*	0.0962**	0.0819
log(Area)	0.0486**	0.0159	0.0512**
Cerrado region	-0.0420	-0.0838*	-0.0827
Matas region	-0.1187	-0.0837	0.1059
Risk aversion	0.0256	0.0401	-0.0649
Price risk perception	0.1087*	0.0114	0.0872
Input risk perception	0.0202	-0.0443	0.0198
Drought risk perception	-0.0643	-0.0073	-0.1081**
R^2	0.1240	0.0502	0.0555
F stat	4.5303	1.6775	1.8757
Pr(F-stat)	0.0000	0.0767	0.0412
AIC	1.2617	0.7755	1.4169
DW stat	1.9603	1.9305	2.019

*** Significance at 1%; ** Significance at 5%; * Significance at 10%.

The estimated coefficients of the multinomial probit model are shown in Table 6. Focusing on the use of forward contracting and its combination with other tools, we found that risk aversion, mechanization, and leverage have a positive impact on the decision to

use risk management tools. In addition, the negative and significant parameter estimates on the Cerrado and Matas regions reflect a lower likelihood of adopting the combination of forward contracting and barter in these areas relative to the South Minas region.

Table 6. Parameter Estimates from the multinomial probit regression model for estimating the factors influencing the adoption of agricultural price risk management tools.

	Only Forward	**Only Diversification**	**Forward and Diversification**	**Forward and Barter**
Intercept	-5.67163 ***	-1.18872	-8.43284 ***	-7.86589 ***
log(Experience)	0.48927	-0.01936	0.65737	0.27071
Education	0.37630	0.39723	0.46578	0.45270
Leverage	0.27583	-0.72013 *	1.08417 *	0.66769
Mechanization	0.65266	0.64466	1.04747	2.65986 *
log(Area)	0.18523	0.10274	0.46681 **	0.41985 *
Cerrado region	-0.22037	-0.56315	-0.28782	-1.49170 **
Matas region	-0.67391	0.06672	-0.96778	-2.67043 *
Risk aversion	1.52997 *	0.21604	0.06444	1.52039
Coffee price risk perception	0.38857	-0.04199	0.93499	-0.44670
Drought risk perception	-0.27125	-0.21938	-1.16954 *	-0.07496
Input Price risk perception	0.11398	0.35540	0.58968	0.19472
Edf				48.00000
Deviance				811.35254
AIC				907.35254
Obs				322

Note: given that there were few producers in some categories (group 3: only barter operation; group 7: barter and crop diversification; group 8: forward contracting, barter, and crop diversification), these groups were omitted in the multinomial probit analysis.

CONCLUSIONS

Increasing risks in agriculture have affected the vulnerability of farmers, reflected in food security, and undermined the sustainability of the agricultural sector (particularly in developing countries). In general, risk perceptions influence the decision-making process. In agricultural activities, how farmers assess the frequency of risk events and their financial loss shapes their subjective interpretation of risk, impacting the decision to use risk-coping strategies.

Using primary data, obtained from a sample of 385 Brazilian coffee farmers, this study provides relevant information to understand the risk perceptions and factors that influence the use of risk management tools in agricultural activity, especially in coffee farming.

Findings indicated that for coffee farmers the three most important risk events with greater severity perception are input and coffee price fluctuations and drought. In addition, results show that farmers who present higher risk aversion tend to use forward contracts. Business characteristics – such as the size of the farm, mechanization, and leverage have a significant influence on the probability of using forward contracts relative to the spot market (base scenario).

This evaluation is relevant in the face of growing climate uncertainty, which has the potential to impact price volatility and production levels directly. Findings from this research highlight, for instance, the importance of educational programs and awareness actions that explain the risks of the activity and their impact on farming profitability, especially for coffee growers.

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APPENDIX

Appendix 1. P-values of the Mann-Whitney U test

	Variable	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
A.	Input price fluctuation	-							
B.	Coffee price fluctuation	0.1338	-						
C.	Drought	0.0000	0.0000	-					
D.	Lack/Disqualification of the workforce	0.0000	0.0000	0.0000	-				
E.	Prague	0.0000	0.0000	0.0000	0.3930	-			
F.	Plant diseases	0.0000	0.0000	0.0000	0.1499	0.5734	-		
G.	Frost	0.0000	0.0000	0.0000	0.0004	0.0011	0.0093	-	
H.	Hail	0.0000	0.0000	0.0000	0.0002	0.0005	0.0038	0.9841	-
I.	Increase in guarantees for obtaining credit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0007
J.	Change in the rigor of classification standards	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
K.	Credit insufficiency	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
L.	Wind	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
M.	Difficulty in accessing technical assistance	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N.	Farm management issues	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O.	Strikes and interruptions of highways/airports	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
P.	Inadequate soil/water/input management	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Q.	Inadequacy of storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R.	Water contamination	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000