Determination of Natural Risk Sources Effective in Wheat Production in Hadim District with the Help of Linear Programming

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ARTICLE INFO

ABSTRACT

There are many sources of natural risks affecting wheat cultivation. In this study, it is aimed to estimate the minimum and maximum risk ranges and premium and compensation amounts of the natural risk factors affecting the wheat yield in Hadim district of Konya in terms of farmers and insurance.As natural risk factors, disease and pests, frost, drought, hail, fire and the interactions of other risks and factors were examined.The number of factors dealt with in the study is 6, and the total number of linear models created using all combinations is 63.The 63 linear models established, the minimum and maximum risk ranges in terms of farmers and insurance were determined by using the simplex method of linear programming on the basis of yield and price.In addition, diseases and pests and other risk factors not included in the scope of agricultural insurances were included in the linear models and wheat yield was estimated on district basis.In the model with all risk factors, the expected risk value of the farmer is 64.962 (kg / ha-1) -71.588 (TL / ha-1), while it is estimated as 53.548 (kg / ha-1) -59.009 (TL / ha-1) in terms of insurance. has been. As a result, it was estimated that the farmer paid 20,831 (TL / ha-1) premiums and 122,344 (TL / ha-1), while insurance companies paid 59,009 (TL / ha-1) premium 84,018 (TL / ha-1) compensation.

1. Introduction

Agricultural products are under great risk with the increase of global warming and natural disasters in the world. Although there are many factors that affect yield in agricultural products, the biggest share belongs to natural risk factors. Natural risk factors are common from diseases and pests, frost, drought, hail, fire, earthquake, storm, tornado, landslide, flood and other risks. While it is almost impossible to control climatic-induced natural risk factors, it is partially possible to detect them with the help of early warning systems thanks to developing technology. These events, which occur outside the control of the growers, cause fluctuations in the production of agricultural products. These fluctuations in yield cause the farmers to worry economically (Akçaöz, 2006).

The geographical location of both Turkey and also to take part in many climates although it is quite conducive to a variety of agricultural production, the sector is experiencing a troubled period in terms of economy due to reasons such as the lack of efficient production unions, competition among agricultural product exchanges, low education level, rural to urban migration, climate change, deterioration of ecological balance, disasters and disasters.This situation negatively affects both the income of the producer and the national economy (Karaca et al., 2010; Tsikirayi et al., 2013; Cangi & Oruç, 2017).

The main natural risk factors in wheat production are diseases and pests, frost, drought, hail, fire, etc. It is known that it causes significant loss of yield and low quality as a result of not taking into account the risk factors determined during production (Altay, 2019).

Irregular yields of agricultural products pushed producers to seek assurance to continue their activities (Çukur & Saner, 2008; İkikat Tümer, 2011a; İkikat Tümer, 2011b; Karahan Uysal et al., 2014; Terin & Aksoy, 2015; Tümer, 2019).It has become inevitable that agricultural products produced under risk are covered by insurance and partially compensated for

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the losses incurred.One of the ways to overcome these various and common risks in the agricultural sector is agricultural insurance (Binici et al., 2003; İkikat Tümer, 2004).In this context, after previously functioning of private insurance companies in Turkey rose Law Agricultural Insurance in 2005.Agricultural Insurance Pool and TARSİM started their activities in 2006 (Sümer & Polat, 2016).In this context, the development of agricultural policies within the scope of agricultural insurance in recent years is a beacon of hope for our country's producers.

Turkey continues its activities by state agricultural insurance and negotiated private insurance companies. Both premium and policy support are provided to farmers from the agricultural insurance pool fund. In herbal product insurances, 50% of insurance premiums, 66.67% of frost coverage and 60% of district-based drought have been secured by the state for free (Ertan & Gök, 2012; Kızıloğlu, 2017; Anonymous, 2019).

In this study, it is aimed to estimate the minimum and maximum risk ranges and premium and indemnity amounts in terms of farmers and insurance by making risk analysis of natural risk factors that are effective in wheat production in Hadim district.

2. Materials and Methods

Hadim district, located in the south of Konya, is located on the Taşeli Plateau between 36 ° 59 'north latitude and 32 ° 27' east longitude (Figure 1).The average altitude above sea level is 1510 m, the annual average rainfall is 619 mm and the surface area is 921 km^2.Situated on a valley in the Central Taurus Mountains, Hadim is located in the Mediterranean region and does not fully show the characteristic features of the Mediterranean climate (Anonymous, 2018).In this respect, it shows a transition feature between Terrestrial climate and Mediterranean climate (Anonymous, 2018).It receives more precipitation than the terrestrial climate and is among the districts with the highest day and night temperature difference.Mostly grown field products in Hadim are wheat, barley and chickpeas. Among these products, the product with the most growing area is wheat with 60.82%, and the average wheat yield in the district is 280 kg / da (Anony-mous, 2018; Tuik, 2018; Anonymous, 2018a).

Figure 1

Konya province Hadim district map (Anonim, 2018a).

The probability, frequency and corrected probability values of the natural risk factors and interactions examined in the wheat production of Hadim district were determined by the experts in the light of meteorological data. The probability values of interactions were inspired by the probability of occurring two or more events at the same time and were calculated as P (A) xP (B) x… xP (n).In determining the risk frequencies of interactions, the average of the related main risk factors was taken (Table 1).The effects of natural risk factors and interactions examined in the wheat production of Hadim district were evaluated by local farmers, agricultural engineers and faculty members in the light of various literature and determined by brainstorming (Table 2).

Risk analysis consists of two basic components, risk realization probability and risk effect, and it is calculated as Risk = (RGO x RF) x RGE (Erdoğan, 2017).In wheat production, the period of the plant when the risk occurs will change the severity of the risk effect. Therefore, while calculating the risk in wheat production, without ignoring the effect of time (it takes values between 0-3), the frequency of the risk should also be included in the calculation. Taking the frequencies of the risk as the coefficient of the constraints helped to calculate the weighted average of the risks in terms of time.Finally, risk calculation takes the form of Risk = DRO x RGE (RGO: Probability of Risk Realization, RF: Frequency of Risk, RGE: Effect of Risk on Occurrence, DRO: Probability of Adjusted Risk). The formation stages of linear programming were carried out with the following mathematical expressions (Apaydın, 1996; Sucu, 1996; Yapıcı, 2000).The creation of the objective function has been designed and applied in the logic of a multi-factor linear model that varies according to the number of factors.

Objective function;

$Max(Min)Z(x) = CX$

Constraints;$AX \{\leq, =, \geq\} B$

Table 1
Frequencies and Probability of Natural Risks Which are Taken in Wheat Production of Hadim District, Konya

Natural Risks	Symbols	Risk Probability		Risk Frequency		Adjusted Risk Probability	
		Min	Max	Min	Max	Min	Max
Diseases and Pests	x1	0.10	0.20	1.250	2.200	0.125	0.44
Frost	x2	0.15	0.25	1.250	1.950	0.1875	0.4875
Drought	x3	0.05	0.25	1.200	2.050	0.06	0.5125
Hail	x4	0.03	0.08	1.150	1.500	0.0345	0.12
Fire	x5	0.001	0.003	1.030	1.070	0.00103	0.00321
Others	x6	0.15	0.25	1.300	2.350	0.195	0.5875
Diseases and Pests- Frost	x12	0.015	0.05	1.250	2.075	0.01875	0.10375
Diseases and Pests- Drought	x13	0.005	0.05	1.225	2.125	0.006125	0.10625
Diseases and Pests- Hail	x14	0.003	0.016	1.200	1.850	0.0036	0.0296
Diseases and Pests- Fire	x15	0.0001	0.0006	1.140	1.635	0.000114	0.000981
Diseases and Pests- Others	x16	0.015	0.05	1.275	2.275	0.019125	0.11375
Frost- Drought	x23	0.0075	0.0625	1.225	2.000	0.0091875	0.125
Frost- Hail	x24	0.0045	0.02	1.200	1.725	0.0054	0.0345
Frost- Fire	x25	0.00015	0.00075	1.140	1.510	0.000171	0.0011325
Frost- Others	x26	0.0225	0.0625	1.275	2.150	0.0286875	0.134375
Drought- Hail	x34	0.0015	0.02	1.175	1.775	0.0017625	0.0355
Drought- Fire	x35	0.00005	0.00075	1.115	1.560	0.00005575	0.00117
Drought- Others	x36	0.0075	0.0625	1.250	2.200	0.009375	0.1375
Hail- Fire	x45	0.00003	0.00024	1.090	1.285	0.0000327	0.0003084
Hail- Others	x46	0.0045	0.02	1.225	1.925	0.0055125	0.0385
Fire - Others	x56	0.00015	0.00075	1.165	1.710	0.00017475	0.0012825
Diseases and Pests- Frost- Drought	x123	0.00075	0.0125	1.233	2.067	0.000925	0.0258333
Diseases and Pests- Frost- Hail	x124	0.00045	0.004	1.217	1.883	0.0005475	0.0075333
Diseases and Pests- Frost- Fire	x125	0.000015	0.00015	1.177	1.740	0.00001765	0.000261
Diseases and Pests- Frost- Others	x126	0.00225	0.0125	1.267	2.167	0.00285	0.0270833
Diseases and Pests- Drought- Hail	x134	0.00015	0.004	1.200	1.917	0.00018	0.0076667
Diseases and Pests- Drought- Fire	x135	0.000005	0.00015	1.160	1.773	0.0000058	0.000266
Diseases and Pests- Drought- Others	x136	0.00075	0.0125	1.250	2.200	0.0009375	0.0275
Diseases and Pests- Hail- Fire	x145	0.000003	0.00005	1.143	1.590	0.00000343	0.00007950
Diseases and Pests- Hail- Others	x146	0.00045	0.004	1.233	2.017	0.000555	0.0080667
Diseases and Pests- Fire- Others	x156	0.000015	0.00015	1.193	1.873	0.0000179	0.000281
Frost- Drought- Hail	x234	0.000225	0.005	1.200	1.833	0.00027	0.0091667
Frost- Drought- Fire	x235	0.0000075	0.000188	1.160	1.690	0.0000087	0.0003177
Frost- Drought- Others	x236	0.001125	0.015625	1.250	2.117	0.00140625	0.0330729
Frost-- Hail- Fire	x245	0.0000045	0.00006	1.143	1.507	0.000005145	0.0000904
Frost- Hail- Others	x246	0.000675	0.005	1.233	1.933	0.0008325	0.0096667
Frost- Fire- Others	x256	0.0000225	0.000188	1.193	1.790	0.00002685	0.0003365
Drought- Hail- Fire	x345	0.0000015	0.00006	1.127	1.540	0.00000169	0.00009240
Drought- Hail- Others	x346	0.000225	0.005	1.217	1.967	0.00027375	0.0098333
Drought- Fire- Others	x356	0.0000075	0.000188	1.177	1.823	0.000008825	0.0003428
Hail- Fire- Others	x456	0.0000045	0.00006	1.160	1.640	0.00000522	0.00009840
Diseases and Pests- Frost- Drought- Hail	x1234	0.0000225	0.001	1.213	1.925	0.00002728	0.001925
Diseases and Pests- Frost- Drought- Fire	x1235	0.00000075	0.000038	1.183	1.818	0.00000089	0.00006907
Diseases and Pests- Frost- Drought- Others	x1236	0.0001125	0.003125	1.250	2.138	0.000140625	0.0066797
Diseases and Pests- Frost- Hail- Fire	x1245	0.00000045	0.000012	1.170	1.680	0.00000053	0.00002016
Diseases and Pests- Frost- Hail- Others	x1246	0.0000675	0.001	1.238	2.000	0.00008353	0.002
Diseases and Pests- Frost- Fire- Others	x1256	0.000002	0.00004	1.208	1.893	0.000002415	0.00007570
Diseases and Pests- Drought- Hail- Fire	x1345	0.00000015	0.00001	1.158	1.705	0.00000017	0.00001705
Diseases and Pests- Drought- Hail- Others	x1346	0.0000225	0.001	1.633	2.700	0.00003675	0.0027
Diseases and Pests- Drought- Fire- Others	x1356	0.00000075	0.00004	1.195	1.918	0.00000090	0.00007670
Diseases and Pests- Hail- Fire- Others	x1456	0.00000045	0.000012	1.183	1.780	0.00000053	0.00002136
Frost- Drought- Hail- Fire	x2345	0.000000225	0.000015	1.158	1.643	0.00000026	0.00002464
Frost- Drought- Hail- Others	x2346	0.00003375	0.00125	1.225	1.963	0.00004134	0.0024531
Frost- Drought- Fire- Others	x2356	0.0000011	0.000047	1.195	1.855	0.00000131	0.00008719
Frost- Hail- Fire- Others	x2456	0.0000007	0.000015	1.183	1.718	0.00000083	0.00002576
Drought- Hail- Fire- Others	x3456	0.000000225	0.000015	1.170	1.743	0.00000026	0.00002614
Diseases and Pests- Frost- Drought- Hail-Fire	x12345	0.000000023	0.000003	1.176	1.754	0.00000003	0.00000526
Diseases and Pests- Frost- Drought- Hail- Others	x12346	0.000003	0.00025	1.230	2.010	0.00000369	0.0005025
Diseases and Pests- Frost- Drought- Fire- Others	x12356	0.0000001	0.000009	1.206	1.924	0.00000012	0.00001732
Diseases and Pests- Frost- Hail- Fire- Others	x12456	0.00000007	0.0000030	1.196	1.814	0.00000008	0.00000544
Diseases and Pests- Drought- Hail-Fire- Others	x13456	0.000000023	0.000003	1.186	1.834	0.00000003	0.00000550
Frost- Drought- Hail-Fire- Others	x23456	0.000000034	0.000004	1.186	1.784	0.00000004	0.00000714
Diseases and Pests-Frost- Drought-Hail-Fire-Others	x123456	0.0000000034	0.0000008	1.197	1.853	0.000000004	0.00000148

Table 2
Effect of Natural Risks Which are Taken in Wheat Production of Hadim District, Konya

Natural Risks	Symbols	Effect of Risks for Farmer (kg/ha^{-1})		Effect of Risks for Insurance (kg/ha^{-1})	
		Min	Max	Min	Max
Diseases and Pests	x1	45	120	0	0
Frost	x2	25	115	40	65
Drought	x3	20	75	40	45
Hail	x4	20	130	30	70
Fire	x5	10	280	20	200
Others	x6	35	145	80	100
Diseases and Pests- Frost	x12	30	155	60	100
Diseases and Pests- Drought	x13	35	135	55	85
Diseases and Pests- Hail	x14	40	180	60	110
Diseases and Pests- Fire	x15	35	280	55	200
Diseases and Pests- Others	x16	60	190	95	120
Frost- Drought	x23	35	130	65	85
Frost- Hail	x24	35	145	55	90
Frost- Fire	x25	30	280	45	200
Frost- Others	x26	55	155	85	95
Drought- Hail	x34	35	140	55	85
Drought- Fire	x35	30	280	45	200
Drought- Others	x36	65	155	95	95
Hail- Fire	x45	25	280	35	200
Hail- Others	x46	50	165	75	105
Fire - Others	x56	55	280	70	200
Diseases and Pests- Frost- Drought	x123	65	195	90	100
Diseases and Pests- Frost- Hail	x124	50	190	70	95
Diseases and Pests- Frost- Fire	x125	50	280	70	200
Diseases and Pests- Frost- Others	x126	60	185	90	100
Diseases and Pests- Drought- Hail	x134	55	180	80	95
Diseases and Pests- Drought- Fire	x135	55	280	85	200
Diseases and Pests- Drought- Others	x136	65	175	90	100
Diseases and Pests- Hail- Fire	x145	45	280	65	200
Diseases and Pests- Hail- Others	x146	50	185	70	105
Diseases and Pests- Fire- Others	x156	55	280	75	200
Frost- Drought- Hail	x234	55	190	85	105
Frost- Drought- Fire	x235	60	280	90	200
Frost- Drought- Others	x236	65	180	95	100
Frost- Hail- Fire	x245	40	280	60	200
Frost- Hail- Others	x246	60	200	85	110
Frost- Fire- Others	x256	55	280	75	200
Drought- Hail- Fire	x345	50	280	70	200
Drought- Hail- Others	x346	65	185	95	100
Drought- Fire- Others	x356	65	280	100	200
Hail- Fire- Others	x456	50	280	75	200
Diseases and Pests- Frost- Drought- Hail	x1234	80	200	110	120
Diseases and Pests- Frost- Drought- Fire	x1235	90	280	115	200
Diseases and Pests- Frost- Drought- Others	x1236	85	210	110	120
Diseases and Pests- Frost- Hail- Fire	x1245	85	280	115	200
Diseases and Pests- Frost- Hail- Others	x1246	95	225	120	125
Diseases and Pests- Frost- Fire- Others	x1256	90	280	125	200
Diseases and Pests- Drought- Hail- Fire	x1345	85	280	115	200
Diseases and Pests- Drought- Hail- Others	x1346	85	190	110	110
Diseases and Pests- Drought- Fire- Others	x1356	85	280	115	200
Diseases and Pests- Hail- Fire- Others	x1456	90	280	120	200
Frost- Drought- Hail- Fire	x2345	95	280	130	200
Frost- Drought- Hail- Others	x2346	100	225	135	120
Frost- Drought- Fire- Others	x2356	100	280	140	200
Frost- Hail- Fire- Others	x2456	105	280	145	200
Drought- Hail- Fire- Others	x3456	85	280	110	200
Diseases and Pests- Frost- Drought- Hail-Fire	x12345	100	280	140	200
Diseases and Pests- Frost- Drought- Hail- Others	x12346	110	230	150	125
Diseases and Pests- Frost- Drought- Fire- Others	x12356	110	280	145	200
Diseases and Pests- Frost- Hail- Fire- Others	x12456	110	280	155	200
Diseases and Pests- Drought- Hail-Fire- Others	x13456	100	280	135	200
Frost- Drought- Hail-Fire- Others	x23456	115	280	160	200
Diseases and Pests-Frost- Drought-Hail-Fire-Others	x123456	120	280	165	200

Positivity requirement;

$X \geq 0$ this is expressed in the form. In this place;

$C = [c_1, c_2, \ldots, c_n]$,

$$X = \begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ . \\ x_n \end{bmatrix},$$

$$A = \begin{bmatrix} a_{11} a_{12} \ldots a_{1n} \\ a_{21} a_{22} \ldots a_{2n} \\ . \quad . \quad . \\ . \quad . \quad . \\ . \quad . \ldots . \\ a_{m1} a_{m1} \ldots a_{mn} \end{bmatrix},$$

$$B = [b_1, b_2, \ldots, b_m]^T = \begin{bmatrix} b_1 \\ b_2 \\ . \\ . \\ . \\ b_m \end{bmatrix},$$

C: (1 x n) dimensional objective function coefficients vector (Adjusted Probability of Risk),

X: (n x 1) dimensional decision variables vector (Risk Factors and Interactions),

A: (m x n) dimensional constraint coefficients matrix (Frequency of Risk),

B: (m x 1) is the vector of the values of the dimensional constraints (Effect of Risk).

The risk analysis of this study was obtained with thehelp of the version 24.1.3.CPLEX algorithm version 2.5.1.0 of the GAMS package program of the generated linear 63 different risk models.

3. Results and Discussion

The results of the risk models created for the wheat yield of the Konya province Hadim district are given in Table 3 in terms of farmer and insurance based minimum and maximum risk ranges in terms of yield (kg / ha^{-1}) and wage (TL / ha^{-1}). There are huge differences in terms of some risk factors in terms of farmers and insurance. Some of these differences are closing due to premium support. In terms of natural risks, 50% of the premium, 66.67% of the frost coverage and 60% of the drought are covered by the state (Çiftçi, 2014). However, it is thought that the district-based

natural risk factors are slightly below the expectations of the farmers because they only cover the drought risk and the disease pests and other risk factors are excluded from the coverage.

Thanks to 63 different models created with linear programming logic, farmers are able to choose the natural risks they want. In this context, the farmer can provide the opportunity to pay less premiums by insuring the natural risk factors he sees as risky for his own region. Similar situations apply to health, vehicle and home insurances. For example, in a place where there is no landslide and hose risk, home and workplace owners can pay lower premiums by excluding these risks from insurance coverage.

Confidence intervals of natural risk factors in terms of farmer and insurance are given in Table 3.The amount of risk expected by the district farmer for diseases and pests is estimated to be between 5.625-52.800 (kg / ha^{-1}).In frost risk, the amount of risk that the farmer expects is between 7,500-56,063 (kg / ha^{-1}), while insurance is 4,688-31,688 (kg / ha^{-1}).While the risk range of the farmer in drought risk is 2,400-38,438 (kg / ha^{-1}), insurance is estimated to be 1,200-23,063 (kg / ha^{-1}).In addition, farmers cannot benefit from the drought risk individually, as the insurance applies a district-based drought insurance. When the hail risk is taken into account, it has been determined that the farmer is 1,035-15,600 (kg / ha^{-1}), while there may be a loss in the range of 0.690-8,400 (kg / ha^{-1}) of insurance.In fire risk, farmer loss is estimated to be between 0.021-0.899 (kg / ha^{-1}), while insurance will be in the range of 0.010-0.642 (kg / ha^{-1}).In case of other risks that cannot be handled individually, the farmer was found to be between 15,600-85,188 (kg / ha^{-1}), while insurance was between 6,825-41,125 (kg / ha^{-1}).

Considering all natural risk factors in wheat production of Hadim district, it was 18.903-111.020 (kg / ha^{-1}) and 20.831-122.344 (TL / ha^{-1}) for the farmer, while in terms of insurance, the risk is expected between 30.854-76.241 (kg / ha^{-1}) and 34.001-84.018 (TL / ha^{-1}). (Table 3).When an evaluation is made in terms of long years, the risk expected by the district farmers in wheat production is 64.962 (kg / ha^{-1}) -71.588 (TL / ha^{-1}), while the risk amount expected by insurance companies is 53.548 (kg / ha^{-1}) -59.009 (TL / ha^{-1}) (Table 4)

Table 3
Results of Farmer and Insurance Risk Analysis in Wheat Production of Hadim District, Konya

Natural Risks (Models)	Symbols	Farmer Risk (kg/ha^{-1})		Insurance Risk (kg/ha^{-1})		Farmer Risk (*TL/ha^{-1})		Insurance Risk (*TL/ha^{-1})	
		Min	Max	Min	Max	Min	Max	Min	Max
Diseases and Pests	x1	5.625	52.800	0.000	0.000	6.199	58.186	0.000	0.000
Frost	x2	7.500	56.063	4.688	31.688	8.265	61.781	5.166	34.920
Drought	x3	2.400	38.438	1.200	23.063	2.645	42.359	1.322	25.415
Hail	x4	1.035	15.600	0.690	8.400	1.141	17.191	0.760	9.257
Fire	x5	0.021	0.899	0.010	0.642	0.023	0.991	0.011	0.707

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Others	x6	15.600	85.188	6.825	41.125	17.191	93.877	7.521	45.320
Diseases and Pests- Frost	x12	8.700	44.500	8.900	21.250	9.587	49.039	9.808	23.418
Diseases and Pests- Drought	x13	5.675	37.500	3.025	15.500	6.254	41.325	3.334	17.081
Diseases and Pests- Hail	x14	5.220	31.680	1.980	7.360	5.752	34.911	2.182	8.111
Diseases and Pests- Fire	x15	4.513	24.661	0.060	0.737	4.973	27.176	0.066	0.812
Diseases and Pests- Others	x16	10.650	54.750	14.925	31.000	11.736	60.335	16.447	34.162
Frost- Drought	x23	5.012	40.625	8.488	26.562	5.523	44.769	9.354	29.271
Frost- Hail	x24	4.508	34.050	7.148	20.050	4.968	37.523	7.877	22.095
Frost- Fire	x25	3.765	29.469	6.027	16.816	4.149	32.475	6.642	18.531
Frost- Others	x26	10.238	48.438	19.913	29.687	11.282	53.379	21.944	32.715
Drought- Hail	x34	1.653	26.750	2.983	16.150	1.822	29.479	3.287	17.797
Drought- Fire	x35	1.012	19.592	2.022	11.878	1.115	21.590	2.228	13.090
Drought- Others	x36	7.237	48.438	14.713	29.687	7.975	53.379	16.214	32.715
Hail- Fire	x45	0.611	10.930	0.921	6.049	0.673	12.045	1.015	6.666
Hail- Others	x46	6.075	41.150	13.238	27.500	6.695	45.347	14.588	30.305
Fire - Others	x56	5.278	36.865	12.031	25.450	5.816	40.625	13.258	28.046
Diseases and Pests- Frost- Drought	x123	10.186	70.445	11.730	37.062	11.225	77.630	12.926	40.842
Diseases and Pests- Frost- Hail	x124	9.609	53.509	10.572	27.190	10.589	58.967	11.650	29.963
Diseases and Pests- Frost- Fire	x125	8.719	45.223	8.948	21.955	9.608	49.836	9.861	24.194
Diseases and Pests- Frost- Others	x126	16.222	73.946	24.440	41.937	17.877	81.488	26.933	46.215
Diseases and Pests- Drought- Hail	x134	6.464	47.392	5.112	22.540	7.123	52.226	5.633	24.839
Diseases and Pests- Drought- Fire	x135	5.690	38.247	3.088	16.265	6.270	42.148	3.403	17.924
Diseases and Pests- Drought- Others	x136	12.861	70.839	17.980	42.438	14.173	78.065	19.814	46.767
Diseases and Pests- Hail- Fire	x145	5.243	32.013	2.055	7.928	5.778	35.278	2.265	8.737
Diseases and Pests- Hail- Others	x146	11.626	60.598	16.837	35.680	12.812	66.779	18.554	39.319
Diseases and Pests- Fire- Others	x156	10.683	55.359	14.982	31.600	11.773	61.006	16.510	34.823
Frost- Drought- Hail	x234	5.835	52.075	9.737	32.188	6.430	57.387	10.730	35.471
Frost- Drought- Fire	x235	5.034	41.548	8.517	27.245	5.547	45.786	9.386	30.024
Frost- Drought- Others	x236	11.323	75.312	21.307	43.750	12.478	82.994	23.480	48.213
Frost- Hail- Fire	x245	4.523	34.749	7.176	20.590	4.984	38.293	7.908	22.690
Frost- Hail- Others	x246	11.261	59.238	21.455	35.338	12.410	65.280	23.643	38.942
Frost- Fire- Others	x256	10.266	49.285	19.951	30.340	11.313	54.312	21.986	33.435
Drought- Hail- Fire	x345	1.665	27.464	3.006	16.705	1.835	30.265	3.313	18.409
Drought- Hail- Others	x346	8.130	57.862	16.054	34.387	8.959	63.764	17.692	37.894
Drought- Fire- Others	x356	7.268	49.285	14.746	30.340	8.009	54.312	16.250	33.435
Hail- Fire- Others	x456	6.104	41.789	13.269	27.995	6.727	46.051	14.622	30.850
Diseases and Pests- Frost- Drought- Hail	x1234	10.824	82.422	12.557	45.327	11.928	90.829	13.838	49.950
Diseases and Pests- Frost- Drought- Fire	x1235	9.538	71.552	10.974	37.932	10.511	78.850	12.093	41.801
Diseases and Pests- Frost- Drought- Others	x1236	17.018	112.905	25.290	63.062	18.754	124.421	27.870	69.494
Diseases and Pests- Frost- Hail- Fire	x1245	9.204	54.381	10.304	27.892	10.143	59.928	11.355	30.737
Diseases and Pests- Frost- Hail- Others	x1246	16.072	95.982	24.274	50.149	17.711	105.772	26.750	55.264
Diseases and Pests- Frost- Fire- Others	x1256	15.015	75.020	22.413	42.778	16.547	82.672	24.699	47.141
Diseases and Pests- Drought- Hail- Fire	x1345	5.791	48.321	4.254	23.257	6.382	53.250	4.688	25.629
Diseases and Pests- Drought- Hail- Others	x1346	12.173	95.804	15.633	48.895	13.415	105.576	17.228	53.882
Diseases and Pests- Drought- Fire- Others	x1356	11.260	71.926	14.527	41.966	12.409	79.262	16.009	46.247
Diseases and Pests- Hail- Fire- Others	x1456	10.438	59.760	12.811	36.337	11.503	65.856	14.118	40.043
Frost- Drought- Hail- Fire	x2345	5.520	52.923	9.100	32.885	6.083	58.321	10.028	36.239
Frost- Drought- Hail- Others	x2346	12.263	96.668	21.390	52.675	13.514	106.528	23.572	58.048
Frost- Drought- Fire- Others	x2356	11.498	77.866	20.230	45.659	12.671	85.808	22.293	50.316
Frost- Hail- Fire- Others	x2456	10.427	66.990	18.739	38.570	11.491	73.823	20.650	42.504
Drought- Hail- Fire- Others	x3456	6.906	58.725	13.722	35.100	7.610	64.715	15.122	38.680
Diseases and Pests- Frost- Drought- Hail-Fire	x12345	11.032	83.274	13.936	46.228	12.157	91.768	15.357	50.943
Diseases and Pests- Frost- Drought- Hail- Others	x12346	18.270	132.332	30.408	75.320	20.134	145.830	33.510	83.003
Diseases and Pests- Frost- Drought- Fire- Others	x12356	17.701	114.144	28.625	64.177	19.507	125.787	31.545	70.723
Diseases and Pests- Frost- Hail- Fire- Others	x12456	13.545	89.930	26.599	51.103	14.927	99.103	29.312	56.316
Diseases and Pests- Drought- Hail-Fire- Others	x13456	14.688	84.761	20.436	49.473	16.186	93.407	22.520	54.519
Frost- Drought- Hail-Fire- Others	x23456	12.815	92.166	25.312	53.581	14.122	101.567	27.894	59.046
Diseases and Pests-Frost- Drought-Hail-Fire-Others	x123456	18.903	111.020	30.854	76.241	20.831	122.344	34.001	84.018

*The unit price of wheat kilogram is taken as 1.102 TL

Table 4
Expected Results of Farmer and Insurance Risk Analysis in Wheat Production of Hadim District, Konya

Natural Risks (Models)	Symbols	Farmer Risk (kg/ha^{-1}) Minimum Expected	Insurance Risk (kg/ha^{-1}) Minimum Expected	Farmer Risk (kg/ha^{-1}) Maximum Expected	Insurance Risk (kg/ha^{-1}) Maximum Expected
Diseases and Pests	x1	29.213	0.000	32.192	0.000
Frost	x2	31.782	18.188	35.023	20.043
Drought	x3	20.419	12.132	22.502	13.369
Hail	x4	8.318	4.545	9.166	5.009
Fire	x5	0.460	0.326	0.507	0.359
Others	x6	50.394	23.975	55.534	26.420
Diseases and Pests- Frost	x12	26.600	15.075	29.313	16.613
Diseases and Pests- Drought	x13	21.588	9.263	23.789	10.207
Diseases and Pests- Hail	x14	18.450	4.670	20.332	5.146
Diseases and Pests- Fire	x15	14.587	0.399	16.075	0.439
Diseases and Pests- Others	x16	32.700	22.963	36.035	25.305
Frost- Drought	x23	22.819	17.525	25.146	19.313
Frost- Hail	x24	19.279	13.599	21.245	14.986
Frost- Fire	x25	16.617	11.422	18.312	12.586
Frost- Others	x26	29.338	24.800	32.330	27.330
Drought- Hail	x34	14.202	9.567	15.650	10.542
Drought- Fire	x35	10.302	6.950	11.353	7.659
Drought- Others	x36	27.838	22.200	30.677	24.464
Hail- Fire	x45	5.771	3.485	6.359	3.840
Hail- Others	x46	23.613	20.369	26.021	22.447
Fire - Others	x56	21.072	18.741	23.221	20.652
Diseases and Pests- Frost- Drought	x123	40.316	24.396	44.428	26.884
Diseases and Pests- Frost- Hail	x124	31.559	18.881	34.778	20.807
Diseases and Pests- Frost- Fire	x125	26.971	15.452	29.722	17.028
Diseases and Pests- Frost- Others	x126	45.084	33.189	49.683	36.574
Diseases and Pests- Drought- Hail	x134	26.928	13.826	29.675	15.236
Diseases and Pests- Drought- Fire	x135	21.969	9.677	24.209	10.664
Diseases and Pests- Drought- Others	x136	41.850	30.209	46.119	33.290
Diseases and Pests- Hail- Fire	x145	18.628	4.992	20.528	5.501
Diseases and Pests- Hail- Others	x146	36.112	26.259	39.795	28.937
Diseases and Pests- Fire- Others	x156	33.021	23.291	36.389	25.667
Frost- Drought- Hail	x234	28.955	20.963	31.908	23.101
Frost- Drought- Fire	x235	23.291	17.881	25.667	19.705
Frost- Drought- Others	x236	43.318	32.529	47.736	35.846
Frost- Hail- Fire	x245	19.636	13.883	21.639	15.299
Frost- Hail- Others	x246	35.250	28.397	38.845	31.293
Frost- Fire- Others	x256	29.776	25.146	32.813	27.710
Drought- Hail- Fire	x345	14.565	9.856	16.050	10.861
Drought- Hail- Others	x346	32.996	25.221	36.362	27.793
Drought- Fire- Others	x356	28.277	22.543	31.161	24.842
Hail- Fire- Others	x456	23.947	20.632	26.389	22.736
Diseases and Pests- Frost- Drought- Hail	x1234	46.623	28.942	51.379	31.894
Diseases and Pests- Frost- Drought- Fire	x1235	40.545	24.453	44.681	26.947
Diseases and Pests- Frost- Drought- Others	x1236	64.962	44.176	71.588	48.682
Diseases and Pests- Frost- Hail- Fire	x1245	31.793	19.098	35.036	21.046
Diseases and Pests- Frost- Hail- Others	x1246	56.027	37.212	61.742	41.007
Diseases and Pests- Frost- Fire- Others	x1256	45.018	32.596	49.610	35.920
Diseases and Pests- Drought- Hail- Fire	x1345	27.056	13.756	29.816	15.159
Diseases and Pests- Drought- Hail- Others	x1346	53.989	32.264	59.496	35.555
Diseases and Pests- Drought- Fire- Others	x1356	41.593	28.247	45.836	31.128
Diseases and Pests- Hail- Fire- Others	x1456	35.099	24.574	38.680	27.081
Frost- Drought- Hail- Fire	x2345	29.222	20.993	32.202	23.134
Frost- Drought- Hail- Others	x2346	54.466	37.033	60.021	40.810
Frost- Drought- Fire- Others	x2356	44.682	32.945	49.240	36.305
Frost- Hail- Fire- Others	x2456	38.709	28.655	42.657	31.577
Drought- Hail- Fire- Others	x3456	32.816	24.411	36.163	26.901
Diseases and Pests- Frost- Drought- Hail-Fire	x12345	47.153	30.082	51.963	33.150
Diseases and Pests- Frost- Drought- Hail- Others	x12346	75.301	52.864	82.982	58.256
Diseases and Pests- Frost- Drought- Fire- Others	x12356	65.923	46.401	72.647	51.134
Diseases and Pests- Frost- Hail- Fire- Others	x12456	51.738	38.851	57.015	42.814
Diseases and Pests- Drought- Hail-Fire- Others	x13456	49.725	34.955	54.796	38.520
Frost- Drought- Hail-Fire- Others	x23456	52.491	39.447	57.845	43.470
Diseases and Pests-Frost- Drought-Hail-Fire-Others	x123456	64.962	53.548	71.588	59.009

Table 5
Premiums and Compensation Results in terms of Farmers and Insurance in Wheat Production of Hadim District, Konya

Natural Risks (Models)	Symbols	Farmer Risk (kg/ha⁻¹)		Insurance Risk (kg/ha⁻¹)		Farmer Risk (*TL/ha⁻¹)		Insurance Risk (*TL/ha⁻¹)	
		Prem	Comp	Prem	Comp	Prem	Comp	Prem	Comp
Diseases and Pests	x1	5.625	52.800	0.000	0.000	6.199	58.186	0.000	0.000
Frost	x2	7.500	56.063	4.688	31.688	8.265	61.781	5.166	34.920
Drought	x3	2.400	38.438	1.200	23.063	2.645	42.359	1.322	25.415
Hail	x4	1.035	15.600	0.690	8.400	1.141	17.191	0.760	9.257
Fire	x5	0.021	0.899	0.010	0.642	0.023	0.991	0.011	0.707
Others	x6	15.600	85.188	6.825	41.125	17.191	93.877	7.521	45.320
Diseases and Pests- Frost	x12	8.700	44.500	8.900	21.250	9.587	49.039	9.808	23.418
Diseases and Pests- Drought	x13	5.675	37.500	3.025	15.500	6.254	41.325	3.334	17.081
Diseases and Pests- Hail	x14	5.220	31.680	1.980	7.360	5.752	34.911	2.182	8.111
Diseases and Pests- Fire	x15	4.513	24.661	0.060	0.737	4.973	27.176	0.066	0.812
Diseases and Pests- Others	x16	10.650	54.750	14.925	31.000	11.736	60.335	16.447	34.162
Frost- Drought	x23	5.012	40.625	8.488	26.562	5.523	44.769	9.354	29.271
Frost- Hail	x24	4.508	34.050	7.148	20.050	4.968	37.523	7.877	22.095
Frost- Fire	x25	3.765	29.469	6.027	16.816	4.149	32.475	6.642	18.531
Frost- Others	x26	10.238	48.438	19.913	29.687	11.282	53.379	21.944	32.715
Drought- Hail	x34	1.653	26.750	2.983	16.150	1.822	29.479	3.287	17.797
Drought- Fire	x35	1.012	19.592	2.022	11.878	1.115	21.590	2.228	13.090
Drought- Others	x36	7.237	48.438	14.713	29.687	7.975	53.379	16.214	32.715
Hail- Fire	x45	0.611	10.930	0.921	6.049	0.673	12.045	1.015	6.666
Hail- Others	x46	6.075	41.150	13.238	27.500	6.695	45.347	14.588	30.305
Fire - Others	x56	5.278	36.865	12.031	25.450	5.816	40.625	13.258	28.046
Diseases and Pests- Frost- Drought	x123	10.186	70.445	11.730	37.062	11.225	77.630	12.926	40.842
Diseases and Pests- Frost- Hail	x124	9.609	53.509	10.572	27.190	10.589	58.967	11.650	29.963
Diseases and Pests- Frost- Fire	x125	8.719	45.223	8.948	21.955	9.608	49.836	9.861	24.194
Diseases and Pests- Frost- Others	x126	16.222	73.946	24.440	41.937	17.877	81.488	26.933	46.215
Diseases and Pests- Drought- Hail	x134	6.464	47.392	5.112	22.540	7.123	52.226	5.633	24.839
Diseases and Pests- Drought- Fire	x135	5.690	38.247	3.088	16.265	6.270	42.148	3.403	17.924
Diseases and Pests- Drought- Others	x136	12.861	70.839	17.980	42.438	14.173	78.065	19.814	46.767
Diseases and Pests- Hail- Fire	x145	5.243	32.013	2.055	7.928	5.778	35.278	2.265	8.737
Diseases and Pests- Hail- Others	x146	11.626	60.598	16.837	35.680	12.812	66.779	18.554	39.319
Diseases and Pests- Fire- Others	x156	10.683	55.359	14.982	31.600	11.773	61.006	16.510	34.823
Frost- Drought- Hail	x234	5.835	52.075	9.737	32.188	6.430	57.387	10.730	35.471
Frost- Drought- Fire	x235	5.034	41.548	8.517	27.245	5.547	45.786	9.386	30.024
Frost- Drought- Others	x236	11.323	75.312	21.307	43.750	12.478	82.994	23.480	48.213
Frost- Hail- Fire	x245	4.523	34.749	7.176	20.590	4.984	38.293	7.908	22.690
Frost- Hail- Others	x246	11.261	59.238	21.455	35.338	12.410	65.280	23.643	38.942
Frost- Fire- Others	x256	10.266	49.285	19.951	30.340	11.313	54.312	21.986	33.435
Drought- Hail- Fire	x345	1.665	27.464	3.006	16.705	1.835	30.265	3.313	18.409
Drought- Hail- Others	x346	8.130	57.862	16.054	34.387	8.959	63.764	17.692	37.894
Drought- Fire- Others	x356	7.268	49.285	14.746	30.340	8.009	54.312	16.250	33.435
Hail- Fire- Others	x456	6.104	41.789	13.269	27.995	6.727	46.051	14.622	30.850
Diseases and Pests- Frost- Drought- Hail	x1234	10.824	82.422	12.557	45.327	11.928	90.829	13.838	49.950
Diseases and Pests- Frost- Drought- Fire	x1235	9.538	71.552	10.974	37.932	10.511	78.850	12.093	41.801
Diseases and Pests- Frost- Drought- Others	x1236	17.018	112.905	25.290	63.062	18.754	124.421	27.870	69.494
Diseases and Pests- Frost- Hail- Fire	x1245	9.204	54.381	10.304	27.892	10.143	59.928	11.355	30.737
Diseases and Pests- Frost- Hail- Others	x1246	16.072	95.982	24.274	50.149	17.711	105.772	26.750	55.264
Diseases and Pests- Frost- Fire- Others	x1256	15.015	75.020	22.413	42.778	16.547	82.672	24.699	47.141
Diseases and Pests- Drought- Hail- Fire	x1345	5.791	48.321	4.254	23.257	6.382	53.250	4.688	25.629
Diseases and Pests- Drought- Hail- Others	x1346	12.173	95.804	15.633	48.895	13.415	105.576	17.228	53.882
Diseases and Pests- Drought- Fire- Others	x1356	11.260	71.926	14.527	41.966	12.409	79.262	16.009	46.247
Diseases and Pests- Hail- Fire- Others	x1456	10.438	59.760	12.811	36.337	11.503	65.856	14.118	40.043
Frost- Drought- Hail- Fire	x2345	5.520	52.923	9.100	32.885	6.083	58.321	10.028	36.239
Frost- Drought- Hail- Others	x2346	12.263	96.668	21.390	52.675	13.514	106.528	23.572	58.048
Frost- Drought- Fire- Others	x2356	11.498	77.866	20.230	45.659	12.671	85.808	22.293	50.316
Frost- Hail- Fire- Others	x2456	10.427	66.990	18.739	38.570	11.491	73.823	20.650	42.504
Drought- Hail- Fire- Others	x3456	6.906	58.725	13.722	35.100	7.610	64.715	15.122	38.680
Diseases and Pests- Frost- Drought- Hail-Fire	x12345	11.032	83.274	13.936	46.228	12.157	91.768	15.357	50.943
Diseases and Pests- Frost- Drought- Hail- Others	x12346	18.270	132.332	30.408	75.320	20.134	145.830	33.510	83.003
Diseases and Pests- Frost- Drought- Fire- Others	x12356	17.701	114.144	28.625	64.177	19.507	125.787	31.545	70.723
Diseases and Pests- Frost- Hail- Fire- Others	x12456	13.545	89.930	26.599	51.103	14.927	99.103	29.312	56.316
Diseases and Pests- Drought- Hail-Fire- Others	x13456	14.688	84.761	20.436	49.473	16.186	93.407	22.520	54.519
Frost- Drought- Hail-Fire- Others	x23456	12.815	92.166	25.312	53.581	14.122	101.567	27.894	59.046
Diseases and Pests-Frost- Drought-Hail-Fire-Others	x123456	18.903	111.020	30.854	76.241	20.831	122.344	34.001	84.018

(Pre: Premium, Comp: Compensation)

Considering the natural risks individually for Hadim district, the farmer pays 6.199 (TL / ha-1) premiums and expects a compensation of 58.186 (TL / ha-1), although diseases and pests are not covered by insurance. In the event of frost risk, the farmer pays 8.265 (TL / ha-1) premium and waits for 61.781 (TL /

ha-1) compensation, while insurance companies pay 20.043 (TL / ha^{-1}) premium 34.920 (TL / ha-1) It has been estimated. The formation of the drought situation, farmers 2,645 (TL / ha^{-1}), premium pay, 42.359 (TL / ha^{-1}) while waiting for compensation, the insurance companies 13.369 (£ / ha-1) premium 25.415 (TL / ha^{-1}) estimated that paying compensation. For hail risk, the premium prices of the farmer and insurance were estimated to be 1.141 (TL / ha^{-1}) -5.009 (TL / ha-1), while the compensation amount was estimated to be 17.191 (TL / ha^{-1}) -9.257 (TL / ha^{-1}).In case of occurrence of the risk of fire, farmer 0023 (TL / ha^{-1}) premium pay 0.991 (TL / ha^{-1}), while compensation expectations, while insurance companies in 0359 (TL / ha^{-1}) premium 0707 (TL / ha^{-1}) to pay compensation. Natural risk factors that could not be addressed in the statistical model were collected under the name of other risks and included in the analysis.In case of other natural risks, the premium prices of the farmer and the insurance are 17.191 (TL / ha^{-1}) -26.420 (TL / ha^{-1}), while the compensation amount is 93.877 (TL / ha^{-1}) - 45.320 (TL / ha^{-1})(Table 5).

In case of occurrence of all natural risks, the farmer pays 20.831 (TL / ha-1) premium and waits for 122.344 (TL / ha-1) compensation, while insurance companies compensate 59.009 (TL / ha-1) premium 84.018 (TL / ha-1). It was estimated that they paid (Table 5).Since half of the premium amount of insurance companies is supported by the state, the premium amount paid by the farmer is 29.505 (TL / ha-1).It has been determined that the premium amount determined by the insurance companies is 29.40% more than the premium amount requested by the farmers. In compensation amounts, it was determined that there is a less than 45.62% of the compensation amount requested by the farmers.

In general, the risk analysis practices of agricultural products are in the form of farmers' attitudes towards risk, determining the risk sources, measuring the risk encountered and creating risk management strategies that can be applied (Hazneci and Ceyhan 2011; Çetin 2012; Bayramoğlu & Kaya 2015; Mancı &Eren 2017).Risk analysis applications in existing studies are economically based, and yield-based and region-based risk analysis studies are quite limited.In this study, an economic-based, yield-based and region-based risk analysis application is discussed in terms of both manufacturers and insurance companies.

It is understood that the study conducted by Altay & Keskin (2018) and the results of our study are partially in agreement.There may be parts of this study that are not compatible with the literature, the main reason for this may be the different levels of climate factors, natural risks and the different wheat yield of the district due to the different district.

4. Conclusions

In this study conducted to determine the natural risks in wheat cultivation in the Hadim district of Kon-

ya, a new risk analysis method has been introduced, and the minimum and maximum risk ranges and premiums and compensation amounts have been determined in terms of farmers and insurance.

The most difficult part in risk analysis applications is the stage of determining the impact of risks. The newly established agricultural risk database in our country creates a huge disadvantage for farmers and insurance companies.Achieving overcoming this disadvantage with qualitative (subjective) methods is a very risky situation.Therefore, quantitative methods should be preferred in solving the problem.With the help of satellite image processing methods (NDVI), which has been developing in recent years, the risk (s) effects can be estimated by processing the images of the risk (s) when they occur, and correlating them with efficiency.In this way, a risk database can be created by accessing satellite images and efficiency information in the past.

Also, Agroshell, Apes, Cropsyst, Daisy, Dssat, Fasset, Hermes, Stics, Wofost etc. In addition to modules, making yield estimates by using satellite images will support healthier and more accurate evaluations in terms of farmers and insurance (Palosuo, 2011; Altay& Keskin 2018).

These problems are eliminated by both the creation of a database and the widespread use of agricultural technologies in developed countries (Uysal, 2005).In addition, considering the advances in geographic information systems and meteorology, it is expected to reduce the yield loss by developing early warning systems suitable for the characteristics of each region.In this context, it is necessary to provide a more qualified risk assessment opportunity by revealing a new risk analysis method.

Although the agricultural insurance pool provides both premium support and policy support to farmers, it sometimes thinks that the producers cannot cover the risks as they expect, as a result of the private insurance companies' desire to keep their profit rates high.

Farmers want to insure all possible risks by paying the least insurance premium. When considered in terms of farmers, it is clear that there are differences in terms of both climatic conditions and the attitudes of farmers engaged in wheat growing against risk.For this reason, the farmer minimum risk amount of the linear models formed was evaluated as the premium and the maximum amount as the amount of compensation.

Determining the minimum and maximum points within the framework of the linear programming logic did not provide a confidence interval for farmers and insurance companies. It may be a better approach that both stakeholders meet at the midpoint and not burden each other economically.

5. Acknowledgements

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