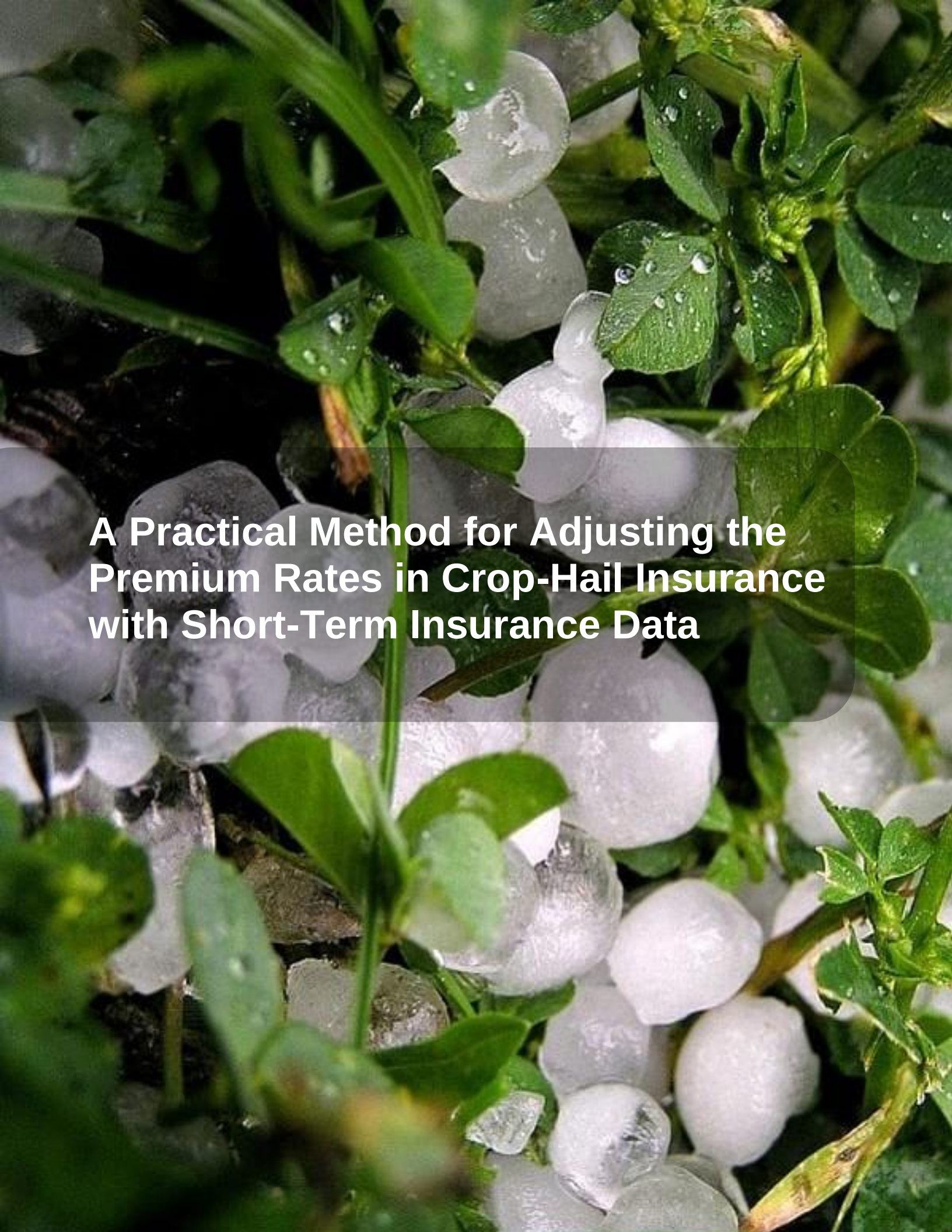

A Practical Method for Adjusting the Premium Rates in Crop-Hail Insurance with Short-Term Insurance Data

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EXECUTIVE SUMMARY

Among the most challenging aspects of crop-hail insurance is setting appropriate premium rates based on short-term[1] insurance data because of the specific characteristics of hailstorms.

The frequency of hailstorms is generally low in small geographic areas. In other words, it may be very likely that hailstorm occurrences will vary between neighboring locations within a short period of time. Besides, a newly launched insurance scheme lacks the data. It is, therefore, difficult to sustain a sound insurance program under these circumstances, with premium rates based on meteorological data without a complimentary adjustment process.

To address this issue, a practical premium rate adjustment method was developed that could be used by insurers with short-term insurance data. This method, which is easy also for non-actuarial people to understand, was developed empirically by conducting simulations of various options in several scenarios.

The essence of this method is to smooth and increase the credibility of villages' loss costs[2] with short-term insurance data by using a set of spatial and temporal adjustment factors. This is accomplished by creating a weighting method for the loss costs of hierarchical geographic units to be established based on the length of the villages' insurance records.

The required premium rates were determined by dividing the weighted loss costs by the target loss ratios. For the final premium rates, as a complement, a parcel-based rate adjustment plan has been designed based on the loss ratio.

The following benefits are expected from this adjustment method and plan soon:

- The required premiums rates will be automatically and objectively determined
- The premium rates calculated will be balanced, fair, and affordable within a few years
- The lowest and highest premium rates of the portfolio will be established automatically
- The portfolio's target loss ratio will be approached after a few years
- Purchasing insurance will be encouraged for farmers with claims-free discount plan
- Adverse selection will be prevented by applying appropriate premium rate in high-risk areas
- Between neighboring villages, large differences in premium rates will be reduced
- Farmers will feel confident about the rating system
- There will be positive effect in insurance penetration.

The initial part of this paper highlights the characteristics and loss potential of hailstorms, the following part of this paper discusses briefly the basic elements of rating, the third part of the paper provides the historical background of premium rates in crop-hail insurance in Turkey, and the fourth part focuses the principles of rate adjustment, and the last part of this paper describes the village-based rate adjustment method and proposes a parcel-based rate adjustment plan.

[1] Short-term: It is assumed to less than 20 years
[2] Loss cost (pure premium): The ratio of indemnities to liabilities, typically averaged over time from historical insurance claims data

INTRODUCTION

The impacts of global climate change are resulting in increased meteorological risks that threaten agricultural production, causing instability in farmers' income and impacting the socioeconomic structure of the rural population negatively. However, agricultural insurance can substantially reduce the negative impact of these risks on a farmer's income, making it the most effective risk management tool. A fair determination of premium rates is one of the most important elements of a well-functioning agricultural insurance scheme and leads to the expansion and sustainability of the system.

In crop-hail insurance which is the oldest and most common type of agricultural insurance, farmers, who believe that the premium rate for crop-hail insurance is too high, do not buy the insurance, while those who consider it too low immediately buy it. Adverse risk selection increases loss ratios and makes insurance unsustainable. It is, therefore, crucial to accurately determine the risk premium rates by location and crop type.

The main reasons that prevent setting the actuarial sound premium rates with short-term crop hail insurance data are:

- Low frequency of hail risk in small geographic areas generally
- Large variability in loss cost within small geographic areas over a short time
- Under or over-estimation of hail risk resulting from short-term insurance data
- Lack of usable data.

The purpose of this paper is to introduce a rate adjustment method for crop-hail insurers that can be understood by non-actuaries and is tailored specifically for short-term insurance data. In this paper, firstly, the characteristics and loss potential of hailstorms are highlighted. Following this, the basic elements of rate-making are briefly discussed. Thirdly, the historical background of premium rates in crop-hail insurance in Turkey is provided. Fourthly, rate adjustment principles in crop-hail insurance are focused. In the last part of the paper, the village-based rate adjustment method is described, and as a fine-tuning, the parcel-based rate adjustment plan is proposed.

THE CHARACTERISTICS AND LOSS POTENTIAL OF HAILSTORMS

The extent of damage caused by hail can reach 100 per cent, depending on the number of hailstorms, the size and density of the hailstones, the wind speed, the temporal and spatial distribution of hailfall, and the type and stage of the crop at the time of the hailstorm. Until the recent decades, hail days have been reported by the public meteorological stations on daily basis as “hail was observed or not observed on the location of the station”.

Hail frequency, which is quantified as the number of hail days per month or year for a given location, is generally low in small geographical areas, while it is high in large ones. In the short term, this may result in a different degree of loss costs between neighboring villages.

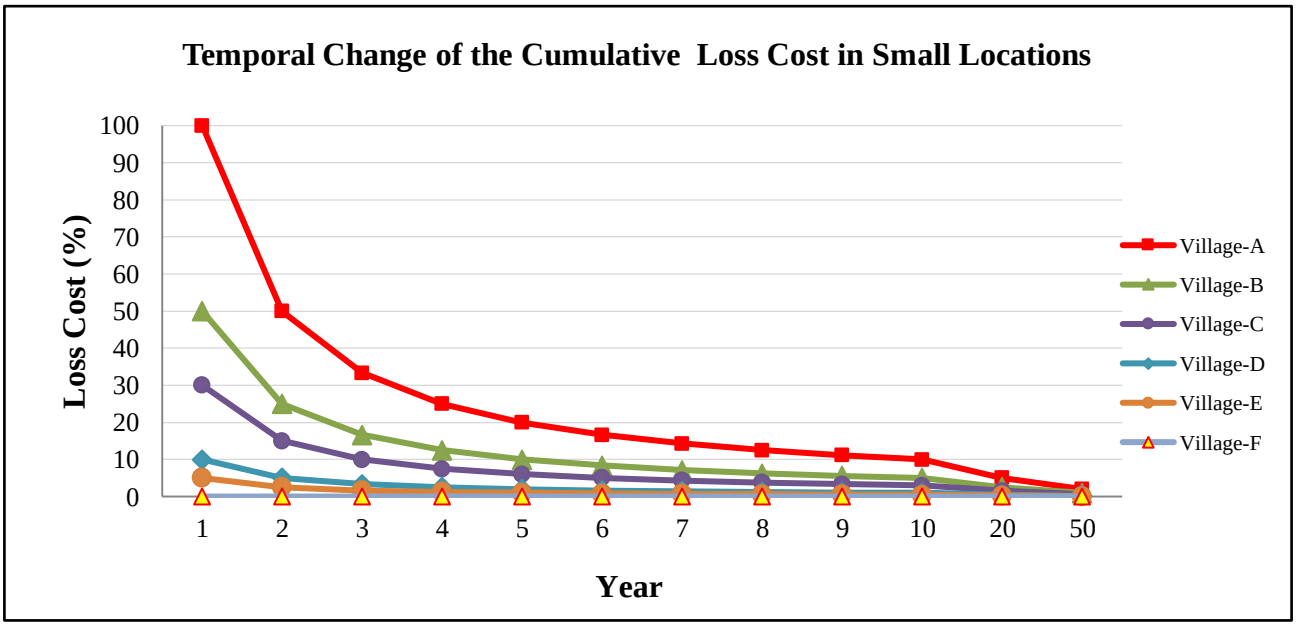
Due to the diversity of regional conditions, such as the presence of lakes, seas, mountains, topography, and microclimatic characteristics, there might also be significant differences in hail frequency in larger regions. Based on data from the Turkish Meteorological Service, the frequencies of hailstorms at a few locations in Turkey indicate very well the differences within and among the regions, as shown in Table 1.

Table 1: Annual Frequency of the Observed Hail Days in Selected Stations

Region	Meteorology Station	Observation (Year)	Annual Frequency
Central Anatolian	Emirdağ	31	1.78
Central Anatolian	Kangal	36	3.16
East Anatolian	Van	36	2.73
East Anatolian	Kars	40	6.81
East Mediterranean	Silifke	31	1.43
East Mediterranean	Dörtyol	35	2.86
Aegean	Aydın	30	1.70
Aegean	Seferihisar	35	2.14
Marmara	Bilecik	30	1.49
Marmara	Uludağ	41	5.38

Due to the low frequency in small areas, hailstorms may not have occurred normally in a particular village for many years. Therefore, if people try to estimate the loss cost for a specific location from a few years of insurance claims data, the result will most likely be inaccurate. For example, if there has been no damage in a village for ten years, losses may have occurred in a nearby village within the same period. This doesn't imply a significant difference in hail hazard between the two neighboring villages in the long term. Chart 1 shows the temporal changes in the cumulative loss cost for six villages. As the difference will be considerably low between those villages in the long term, estimating the damage frequency for the future based on short-term data will not give accurate results.

Chart 1: Temporal Change of the Cumulative Loss Cost in Small Locations



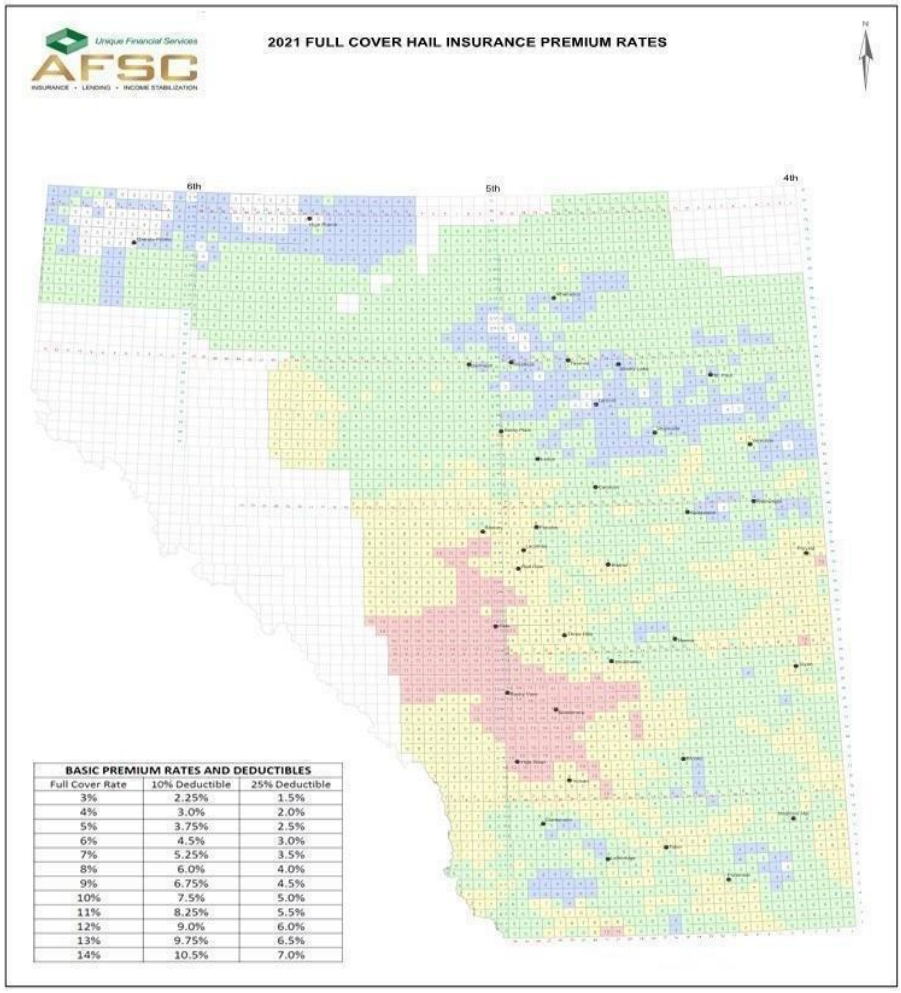
BASIC ELEMENTS OF RATE-MAKING IN CROP-HAIL INSURANCE

In crop-hail insurance, premium rates are determined according to three basic elements: geographical location, deductible, and crop type.

Geographic Unit: The frequency and severity of hailstorms can vary, within a relatively short geographic distance. Therefore, a small geographic unit is an important element for rate-making. Geographic units like villages, taluks, counties or towns, depending on the country are classified as

hail hazard zones based on the frequency and severity of hailstorms to get statistically meaningful results from the insufficient data of individual units. In cases where villages are combined into new administrative areas by government agencies, historical hail loss data need to be treated accordingly. Figure 1 shows the hail risk map of the Southern part of Alberta, Canada, where regular grids are used for the classification of the locations in terms of hail hazards.

Figure 1: Distribution of hail hazard zones in the Southern part of Alberta, Canada



In the case of Turkey, villages are used as the smallest geographic/administrative unit and are divided into 23 hail hazard zones These hail hazard zones are coded from A to Z, where hail hazard zone "A" indicates the area with the lowest risk of hail. Table 2 illustrates a few examples of hail hazard zones in Turkey.

Table 2: Examples of the Hail Hazard Zones of Villages in Turkey

Province	District	Subdistrict	Village	Hail Hazard Zone
Adana	Ceyhan	Kösreli	Adapınar	L
Adana	Kozan	Merkez	Akarca	K
Adana	Yüreğir	Merkez	Aflak	F
Amasya	Merzifon	Alicik	Eymir	S
Amasya	Göynücek	Gediksaray	Gaffarlı	P
Konya	Cihanbeyli	Yeniceoba	Mutlukonak	C
Konya	Derbent	Merkez	Mülayim	B
Konya	Hadım	Merkez	Oduncu	A

When the cumulative loss cost of a village increases, accordingly, the classification of the hail hazard zone of that village is changed. Consequently, premium rates of all crop types grown in the same village will also increase. The premium rate adjustment method developed eliminates such problems related to the classification of crop types and geographic units.

Deductible: Once the adjusted percentage of damage exceeds the deductible, the policy will pay the actual cash value of the insured crop. Due to the relatively higher number of little damaged parcels compared to the number of highly damaged parcels, accumulated damages and high loss adjustment expenses are becoming considerably high costly for insurers. However, a small amount of damage has little effect on farmers. Thus, applying a risk-adequate deductible in crop-hail insurance makes hail insurance more affordable for farmers as premium rates reduced with increasing deductible levels. It means that there is a win-win situation for the insurer and farmers in the deductible application. Depending on the type of deductible to be applied, premium rates are converted by multiplying the premium rates by the deductible factor. The deductible factor can be calculated by dividing the losses paid for which the deductible is applied by the losses paid for which no deductible is applied.

The deductibles in crop-hail insurance typically are applied up to 30% of the insured value. In some countries, the deductible may be applied to the insured value per contract when several fields are insured. The most common form of deductible applied to crop-hail insurance is insurance value per field. However, insurers internationally apply different deductibles, in countries with established crop-hail insurance programs, reducing deductibles, and conditional deductibles with no deductible for a high level of damage, deductible applied to the claim amount. For example, the following deductible types are most commonly offered by hail insurance companies in Canada.

- Full coverage
- 10% disappearing deductible
- 20% disappearing deductible
- 10% deductible with increasing payment factor
- 10% full cover
- 10% straight deductible
- 25% straight deductible
- Excess over 10% loss–disappearing at 50%

The following will provide a brief explanation of each deductible applied:

Full Coverage (Full)

Under full coverage you are paid based on the amount of loss sustained over 5% without any reduction or increase in payment.

10% Deductible Disappearing at 40% (10D)

Under this option, a 10% deductible is charged on all losses up to 30%. Between losses of 30% to 40% the deductible begins to drop. Therefore, after 40% damage to the crop, the deductible disappears completely. The following table more clearly demonstrates how this works.

20% Deductible Disappearing at 60% (20D)

Under this option, a 20% deductible is charged on all losses up to 40%. Between a loss of 40% and 60% the deductible begins to drop, and after 60% damage to the crop, the deductible disappears completely. The following table more clearly demonstrates how this works.

10% Deductible with Increasing Payment Factor (10IP)

Under this option, a 10% deductible is applied to all losses incurred. Thus, any hail loss of 10% or under will result in no payment to you. Once the loss exceeds 70% an increasing payment begins and increases by 1% for each % of loss greater than 70% until the total loss payable becomes 100% of the policy. This will occur at a 90% loss.

Excess Over 10% Loss – Disappearing at 50% (10XS)

Under this deductible all losses over 10% are subject to a 10% deductible, however, the loss in excess of 10% is increased by 25%. Once the hail loss reaches 50% the deductible and increasing payment cease, and it acts as a full coverage scenario would.

10% Straight Deductible (10S)

Under this deductible, all losses are subject to a 10% deductible. Thus, only on losses in excess of 10% will the producer be paid.

25% Straight Deductible (25S)

Under this deductible, all losses are subject to a 25% deductible. Thus, only on losses in excess of 25% will the producer be paid.

Crop Type: The loss costs for crop types in the same location vary because of the differences in their vegetation periods, physical structures, the abilities to regenerate and the vulnerability to hailfall. For example, carrots, potatoes, and sugar beets are less than wheat and corn while tobacco and tree fruits are among the most vulnerable crops.

When there is no experience with crop-hail insurance, insurers usually classify crop types with similar risk profiles into vulnerability classes through judgment. Often, damage experience from countries with similar climate and crop types, is used to derive vulnerability ranges. In Turkey, for instance, crops were divided into six classes based on their vulnerability at the beginning. In the first class, sugar beets were placed; in the second class, wheat, barley, rye, corn, and in the sixth class, tomatoes, cucumbers, strawberries, peaches, apricots, pears, apples, and plums. With accumulated experience over time, vulnerability classes have been updated for different crop types. Tables 3,4,5, and 6 illustrates changes in crop classification. A vulnerability classification is a process of collecting statistically meaningful information that can be used to adjust premium rates even though it is not fully satisfactory.

The disadvantage of this application is that when the vulnerability class of a crop is updated according to the loss experience, all geographic areas where the same crop is grown are affected in the same way. In other words, if the premium rate of a particular crop type is increased, a higher premium rate will be applied in all regions, regardless of the loss costs of a specific location. This will result in unfairness.

HISTORICAL BACKGROUND OF PREMIUM RATES IN CROP-HAIL INSURANCE TURKEY

The premium rates in Turkey are based on the hail hazard zones of the location and the vulnerability of the crops. The reason for categorizing similar crop types into crop classes and locating geographic regions into hail zones is to have a statistically meaningful size of data when creating an insurance program to cover hail damage. Based on the frequency of hail, the provinces were divided into four hail risk zones A, B, C, D, and according to the severity of hail damage crop types were divided into six vulnerability classes in 1970. The classification of the premium rates is shown in Table 3.

Table 3: Crop-Hail Insurance Premium Rates – Turkey (1970)[3]

Crop Class	Field Crops, Vegetables and Seedlings, Fruits, Seedless, Flowers (%)	Hail Hazard Zones and Premium Rates (%)			
		A	B	C	D
1	Sugar and animal beet, green and dry fodder crops, alfalfa, sainfoin), artichoke	0.60	0.70	0.80	0.90
2	Wheat, barley, rye, spa, oats, millet, bird seed, corn, onion, dried garlic, carrot, radish,red beet, turnip, celery, potato), okra, all kinds of fruit nurseries, peanuts	1.50	1.75	2.00	2.25
3	Tobacco, cotton, poppy, rice, beet seeds, legumes (peas, beans, lentils, soybeans,broad beans, chickpeas), vetch, vetch, mulberry, fodder peas, beet seedlings (elite)	2.50	2.75	3.00	3.25
4	Flax, hemp, sunflower, sesame, vegetables, rapeseed, hops, tobacco and vegetable seedlings, hazelnuts, vineyard nurseries, grafted vines, rootstock vines, all kinds of open-grown flowers and roses	3.25	3.50	3.75	4.00
5	Melon, watermelon, beans, peas, broad beans, lettuce, lettuce, spinach, green onions,cabbage, cauliflower, olives, almonds, walnuts, pomegranate, mulberry, cherry	4.00	4.40	4.80	5.50
6	Tomatoes, peppers, cucumbers, eggplants, zucchini (all kinds), strawberries, tree flowers, figs, peaches, apricots, pears, apples, plums, malts, quince, bananas, oranges, lemons, tangerines, grapefruit, pistachios	5.00	5.50	6.00	7.00

Premium rates applied in Turkey in crop-hail insurance for 1977, 1994, and 2014 are displayed in Tables 4–6.

Table 4: Crop-Hail Insurance Premium Rates – Turkey (1977)[4]

Crop Class	Field Crops, Vegetables Seedlings, Fruits, Seedless, Flowers (%)	Hail Hazard Zones and Premium Rates (%)					
		A	B	C	D	E	F
1	Sugar and animal beet, green and dry clover, sainfoin, hay, green corn, potatoes	0.50	0.60	0.70	0.80	0.90	1.00
2	Rye, spa, corn, millet, bird seed, carrot, onion, dried garlic, celery, radish, artichoke, turnip, red beet, all kinds of fruit seedlings, all kinds of nurseries	1.25	1.50	1.75	2.00	2.25	2.50
3	Wheat, barley, oats, paddy, fodder legumes (beans, peas, vetch, vetch, mulberry), edible legumes (beans, peas, chickpeas, soybeans, broad beans, lentils), sunflowers, oil flax, sesame seeds, poppy seeds, rapeseed, peanut, cumin, sugar beet and animal beet seed, beet seed seedling, grass seed, vegetable seed type (all kinds of vegetables)	2.25	2.50	2.75	3.00	3.25	3.50
4	Fibrous plants (cotton, flax, hemp, opium, canned green beans, peas, okra, tobacco, hops, tea gardens, cumin, anise, tobacco and vegetable seedlings, hazelnuts, vineyard nurseries, grafted vines, rootstock vines, open-grown all kinds of flowers and roses	3.00	3.25	3.50	3.75	4.00	4.25
5	Flax, hemp, sunflower, sesame, meadow grasses and vegetables grown for seeds, rapeseed, hops, green fruits and vegetables (beans, peas, broad beans, lettuce, lettuce, spinach, purslane, chard, green onions and garlic), cabbage, leek, cauliflower), olives, mulberry, cherry, sour cherry, medlar, pomegranate, pistachio, raisins	3.60	4.00	4.40	4.80	5.20	5.60
6	Melon, watermelon, tomato (pole and ground), pepper, cucumber, eggplant, zucchini (all kinds), strawberries, tree flowers, figs, peaches, apricots, cherries, apples, pears, plums, malts, quinces, bananas, oranges, lemon, tangerine, grapefruit, table vineyards	4.50	5.00	5.50	6.00	6.50	7.00

[3] Source: Hüseyin TİMUR, Dolu Hasarları Sigortası (1970), Ege Üniversitesi
[4] Source: T.C. Ticaret Bakanlığı (1977)

Table 5: Crop-Hail Insurance Premium Rates – Turkey (1994)[5]

Crop Class	Field Crops, Vegetables Seedlings, Fruits, Saplings and Flowers	Hail Hazard Zones and Premium Rates (%)																						
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	R	S	T	U	V	Y	Z
1	Sugar and animal beet, alfalfa, silage corn, carrot, radish, turnip, hazelnut, almond, walnut, chestnut	0.1	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5
2	Sunflowers, tea, rye, corn kernels, millet, peanuts, artichokes, dried garlic, all kinds of seedlings	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2
3	Wheat, barley, oats, chickpeas, vetch, potato, rapeseed, onion, pomegranate	1.1	1.5	1.9	2.3	2.7	3.1	3.5	3.9	4.3	4.7	5.1	5.5	5.9	6.3	6.7	7.1	7.5	7.9	8.3	8.7	9.1	9.5	9.9
4	Paddy, lentil, sesame, cotton, poppy, broad bean, pea, pistachio, lemon, grapefruit	1.6	2.1	2.6	3.1	3.6	4.1	4.6	5.1	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1	10.6	11.1	11.6	12.1	12.6
5	Cumin, green beans, spinach, cabbage, okra, quince, leeks, oranges, olives, wine grapes,	2.1	2.7	3.3	3.9	4.5	5.1	5.7	6.3	6.9	7.5	8.1	8.7	9.3	9.9	10.5	11.1	11.7	12.3	12.9	13.5	14.1	14.7	15.3
6	Melon, seed sugar beet, pepper, eggplant, apple, avocado, cherry, banana, pear, fig, tangerine	2.6	3.3	4.0	4.7	5.4	6.1	6.8	7.5	8.2	8.9	9.6	10.3	11.0	11.7	12.4	13.1	13.8	14.5	15.2	15.9	16.6	17.3	18.0
7	Tomatoes, plums, kiwis, apricots, watermelon	3.1	3.9	4.7	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.1	11.9	12.7	13.5	14.3	15.1	15.9	16.7	17.5	18.3	19.1	19.9	20.7
8	Zucchini, peach, cherry	3.6	4.5	5.4	6.3	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18.0	18.9	19.8	20.7	21.6	22.5	23.4
9	Hops, lettuce, mulberry, table and dried grapes	4.1	5.1	6.1	7.1	8.1	9.1	10.1	11.1	12.1	13.1	14.1	15.1	16.1	17.1	18.1	19.1	20.1	21.1	22.1	23.1	24.1	25.1	26.1
10	Tobacco, cucumber, strawberry, flowers	4.6	5.7	6.8	7.9	9.0	10.1	11.2	12.3	13.4	14.5	15.6	16.7	17.8	18.9	20.0	21.1	22.2	23.3	24.4	25.5	26.6	27.7	28.8

[5] Source: Munich Re Istanbul, (1994)

Table 6: Crop-Hail Insurance Premium Rates – Turkey (2014)[6]

Crop Class	Crop Types	Hail Hazard Zones and Premium Rates (%)																						
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	R	S	T	U	V	Y	Z
1	Artichoke, Carrot, Celery, Chestnut, Turnip, Sugar Beet, Radish	0.28	0.32	0.36	0.4	0.44	0.48	0.52	0.56	0.64	0.72	0.8	0.88	1	1.12	1.24	1.36	1.52	1.68	1.84	2	2.2	2.4	2.64
2	Nuts	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.8	0.9	1	1.1	1.25	1.4	1.55	1.7	1.9	2.1	2.3	2.5	2.75	3	3.3
3	Sunflower, Tea, Animal Beet,Corn (Grain), Peanut, Corn (Silage) Alfalfa	0.42	0.48	0.54	0.6	0.66	0.72	0.78	0.84	0.96	1.08	1.2	1.32	1.5	1.68	1.86	2.04	2.28	2.52	2.76	3	3.3	3.6	3.96
4	Potatoes	0.49	0.56	0.63	0.7	0.77	0.84	0.91	0.98	1.12	1.26	1.4	1.54	1.75	1.96	2.17	2.38	2.66	2.94	3.22	3.5	3.85	4.2	4.62
5	Rye, Millet, Almonds Fruit Saplings, Garlic	0.56	0.64	0.72	0.8	0.88	0.96	1.04	1.12	1.28	1.44	1.6	1.76	2	2.24	2.48	2.72	3.04	3.36	3.68	4	4.4	4.8	5.28
7	Wheat, Grapefruit, Nutmeg, Cabbage, Lemon, Pomegranate, Chickpea, Onion (Dry), Soy, Triticale, Oats, Cotton, Sainfoin	**0.7**	**0.8**	**0.9**	**1**	**1.1**	**1.2**	**1.3**	**1.4**	**1.6**	**1.8**	**2**	**2.2**	**2.5**	**2.8**	**3.1**	**3.4**	**3.8**	**4.2**	**4.6**	**5**	**5.5**	**6**	**6.6**
8	Fresh Broad Beans, Vetch, Poppy Capsule, Thyme, Hungarian Vetch, Vegetable Seedlings, Sesame, Tobacco Seedlings.	0.84	0.96	1.08	1.2	1.32	1.44	1.56	1.68	1.92	2.16	2.4	2.64	3	3.36	3.72	4.08	4.56	5.04	5.52	6	6.6	7.2	7.92
9	Barley, Broad Bean, Peas, Broccoli, Paddy, Cauliflower, Purslane, Olives)	0.98	1.12	1.26	1.4	1.54	1.68	1.82	1.96	2.24	2.52	2.8	3.08	3.5	3.92	4.34	4.76	5.32	5.88	6.44	7	7.7	8.4	9.24
10	Anise, Lentils, Canola, Fresh Beans, Mint, Fresh Garlic, Fresh Onion, Walnuts	1.12	1.28	1.44	1.6	1.76	1.92	2.08	2.24	2.56	2.88	3.2	3.52	4	4.48	4.96	5.44	6.08	6.72	7.36	8	8.8	9.6	10.56
11	Pistachio, Tangerine, Okra, Leek, Fig, Orange	1.26	1.44	1.62	1.8	1.98	2.16	2.34	2.52	2.88	3.24	3.6	3.96	4.5	5.04	5.58	6.12	6.84	7.56	8.28	9	9.9	10.8	11.88
12	Beans (Dried), Red Pepper, Parsley	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3.2	3.6	4	4.4	5	5.6	6.2	6.8	7.6	8.4	9.2	10	11	12	13.2
13	Spinach, Quince, Pepper, Melon, Grass (Seed), Sugar Beet (Seed), Alfalfa (Seed), Tomato (Paste),Golden Strawberry, Raspberry, Blackberry, Blueberry	1.54	1.76	1.98	2.2	2.42	2.64	2.86	3.08	3.52	3.96	4.4	4.84	5.5	6.16	6.82	7.48	8.36	9.24	10.12	11	12.1	13.2	14.52
14	Avocado, Pumpkin, Tomato (Table), Mulberry, Eggplant, Loquat, Apricot,	1.68	1.92	2.16	2.4	2.64	2.88	3.12	3.36	3.84	4.32	4.8	5.28	6	6.72	7.44	8.16	9.12	10.08	11.04	12	13.2	14.4	15.84
15	Watermelon, Grape (Dry), Grape (Table)	1.82	2.08	2.34	2.6	2.86	3.12	3.38	3.64	4.16	4.68	5.2	5.72	6.5	7.28	8.06	8.84	9.88	10.92	11.96	13	4.3	15.6	17.16
16	Cumin, Banana	1.96	2.24	2.52	2.8	3.08	3.36	3.64	3.92	4.48	5.04	5.6	6.16	7	7.84	8.68	9.52	10.64	11.76	12.88	14	15.4	16.8	18.48
18	Pears, Apple Lettuce, Nectarine, Hops	2.24	2.56	2.88	3.2	3.52	3.84	4.16	4.48	5.12	5.76	6.4	7.04	8	8.96	9.92	10.88	12.16	13.44	14.72	16	17.6	19.2	21.12
19	Plum, Cherry, Cucumber, Cut Flower, Kiwi	2.52	2.88	3.24	3.6	3.96	4.32	4.68	5.04	5.76	6.48	7.2	7.92	9	10.08	11.16	12.24	13.67	15.12	16.56	18	19.8	21.6	23.76

[6] Source: Tarsim, Bitkisel Ürün Sigortası - Tarife ve Talimatlar, (2014)

The revisions of the vulnerability classes for crops and hail hazard zones have been carried out based on actual losses incurred in Turkey. Whenever an increase in premium rates is required because the average loss ratio of a given crop increased, all locations where the same crop is insured experienced the same increase automatically. Likewise, hail hazard zones face the same issue. Consequently, their ratings are unbalanced. As a result, an appropriate rate-making method is needed.

ADJUSTMENT OF PREMIUM RATES USING SHORT-TERM INSURANCE DATA

At the beginning of any insurance program, insurers have to implement initial premium rates, which are calculated based on meteorological data, and they need to adjust the initial premium rates with insurance data using an appropriate method. Before describing the method of rate adjustment with short-term insurance data, it is worthwhile to spend a few minutes looking for answers to the questions in Tables 7–8.

Table 7: A Few Questions That May Come to Mind in Crop-Hail Insurance on a Parcel Basis

Parcel ID	Crop Type	Length of Insurance Records of the Parcel (Years)	Current Premium Rate[7] (%)	Loss Ratio (%)	Required Premium Rate (%)
1-213	Wheat	1	1.00	0	?
1-214	Wheat	1	1.00	5,000	?
1-215	Wheat	10	1.00	500	?
1-216	Wheat	10	1.00	200	?

With respect to short-term insurance records, the questions in Table 7 illustrate that, besides loss ratio, the number of years of insurance data also plays an important role in determining hail premium rates for a given parcel. With regard to villages, the questions in Table 8 also specify that the length of insurance records is a significant factor in determining the hail premium rates in addition to loss cost for villages.

Table 8: A Few Questions That May Come to Mind in Crop-Hail Insurance on a Village Basis

Village	Crop Type	Length of Insurance Records of the Village (Years)	Current Premium Rate[8] (%)	Loss Cost (%)	Required Premium Rate(%)
Ovaköy	Wheat	2	1.00	0.00	?
Kayaköy	Wheat	2	1.00	2.00	?
Tepeköy	Wheat	2	1.00	20.00	?
Dereköy	Wheat	10	1.00	0.00	?
Taşköy	Wheat	10	1.00	2.00	?

Giving the correct answers to the above questions depends on the consideration of the following principles.

[7] Current premium rate refers to the most recent premium rate for villages calculated from either meteorological data or past years' insurance claims

[8] Current premium rate refers to the most recent premium rate for villages calculated from either meteorological data or past years' insurance claims

RATE ADJUSTMENT PRINCIPLES IN CROP-HAIL INSURANCE

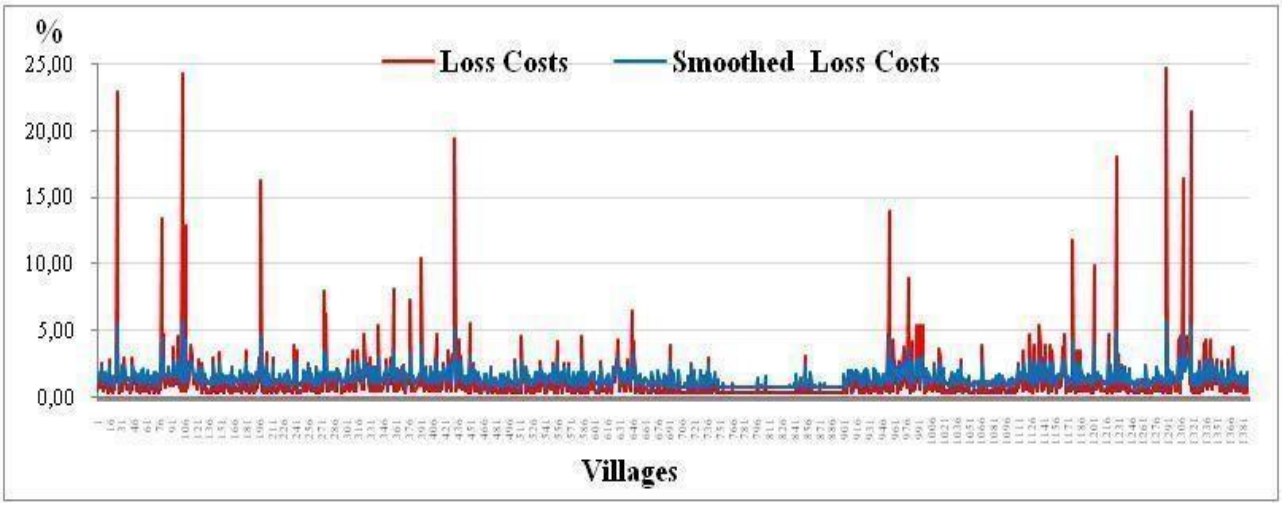
A prerequisite for the calculation of premium rates is to check, clean, verify and put in the format ready for premium rate calculation. The rate adjustment method aims to establish fair and affordable premium rates to avoid anti-selection and moral hazard by the insured. This can be achieved by the following rate adjustment principles set out below.

Percentage of Premium Rates Increase: Radical increase in premium rates does not please farmers. The required premium rate calculated with the rating method might be too high. Insurers should avoid high premiums rates by applying a certain limit to the current premium rate. These limits will be mentioned later.

Smoothing of the Loss Costs of Neighboring Villages: A hailstorm may have not occurred in a village right next to another village that has already experienced a hailstorm in the past decade. There would be a significant difference between the loss costs of neighboring villages.

Nevertheless, the high difference between the two villages could be reduced in the coming decades because of the nature of the hailstorm. Therefore, it is necessary to smooth and normalize the short-term insurance loss cost data of the villages. A visual representation of the smoothing of the villages' loss costs can be found in Chart 2. Using this rate adjustment method, normalization and smoothing are automatically accomplished.

Chart 2: Smoothing of Loss Costs of Villages for Wheat



Necati İÇER, Rating Studies, 2001

Length of Insurance Data Records: Since hailstorms are relatively rare in small geographic areas, determining accurate rates for crop hail insurance takes a considerable effort. In the case of short-term insurance histories, the length of the records of the villages and the establishment of hierarchical geographic units reduce this problem to a great extent, as will be shown later on.

Frequency of Review of the Premium Rates: The frequency of premium rate adjustments is closely related to the nature of hailstorms, whose frequencies may differ dramatically within small regions in the short term. In a small geographic area, hailstorms occur relatively infrequently, causing variation in loss costs among villages in the short term. As a result, it is suggested that rate adjustments are made annually.

Minimum and Maximum Premium Rates: Where there has not been a loss for some years, zero loss cost applies. However, no way to implement zero-premium rates at this location. Hence, it is necessary to establish a minimum premium rate for each location and type of crop. The high loss

costs would require very high premium rates in locations where extreme losses have been occurring for some time, which is simply not affordable. Thus, in locations where there is no loss record, premium rates should be determined in such a way that they should partially compensate for potential losses that may occur in the future and/or losses that have already occurred within the large area. Premium rates should, reflect the projected long-term average loss cost for these high risky areas. Nevertheless, an insurer should not offer insurance unless premiums are subsidized by the government if a risk profile is too high and therefore is not affordable in a given location.

Annual Change in Premium Rates: During the early years of a crop-hail insurance scheme and particularly, in extreme cases, with very severe hailstorm occurrence in a given crop season the required increase in premium rates may well exceed even 200% as shown in the appendix. Nevertheless, the increase in premium rates should be limited to certain levels per year. These limits should be 10% and 20% on a village level and 20% and 40% on a parcel level.

Special Evaluation: If the number of policies throughout the country for some crop types is not enough for rate-making, it will not be possible to adjust initial premium rates appropriately. Premium rates should therefore be adjusted by conducting special evaluations for such crop types. Rate adjustment on a parcel basis can be one of the solutions.

RATE ADJUSTMENT METHOD WITH SHORT TERM INSURANCE DATA

The initial premium rates applied to crop-hail insurance programs are generally determined by the hail frequency data (hail days) provided by state meteorological services. In the analysis of more than 30 years of meteorology data and 10 years of insurance data collected after 2007, there has been no significant correlation between hail frequency and actual losses in Turkish villages.

The main reason for this is that the density of meteorological stations making local observations is insufficient to represent all villages in the region in terms of hail frequency records. Thus, it is believed that a method needs to be used to adjust initial premium rates properly with a short period of insurance data.

Therefore, a rate adjustment method has been developed using the following data and information:

- Length of the insurance records of the villages (year)
- Loss records of the geographic units on a crop type basis
- Premium records of the geographic units on a crop type basis
- Sum Insured[9] records of the geographic units on a crop type basis
- Geo-codes of geographic units (villages, small circles, extended circles)
- Administrative costs, reinsurance costs, commissions, safety margin, profit
- Coordinates of the midpoints of geographic units (parcels, villages, districts, circles)

Since hail frequency varies within small geographic areas, the smallest geographic area should be considered as the "Basic Rating Unit" to reflect risk differences. However, it would be appropriate to define the "Basic Rating Unit" in such a way that it can be published and viewed in print and digital media. Using villages, which are administrative units in the meantime, as the "Basic Rating Unit", will facilitate the monitoring of premium rates in print and digital media. In this case, another problem arises.

[9] Depending on insurance conditions of a crop-hail insurance program, the sum insured may be used as i) commercial value of the crop, calculated fromexpected yield and commodity prices or ii) production costs that represent replacement value of the crop and typically reflect labor cost and expenses for input supplies. Some crop hail policies have escalator endorsements in that the sum insured at planting is low and increases e.g. by 5% each day until the full value is reached. Also, some policies include replanting costs when losses are paid for total damage in early vegetative stages

Due to the small amount of data available in villages; statistically meaningful results cannot be obtained for rating. Besides, the credibility of the loss costs of the villages is rather low in the short-term data set. Consequently, premium rates could differ significantly between neighboring villages in the short term.

In the first few years of crop-hail insurance records, there can be huge differences in the loss costs of hierarchical geographic areas. Chart 3 illustrates the difference between the loss costs of the village, small circles and extended circles on a time series basis. A Turkish example in Chart 4 shows how the loss costs of the hierarchical administrative units have varied over time.

Therefore, temporal and spatial smoothing is the most important element of this rate adjustment method in crop-hail insurance. More specifically, great differences in premium rates among villages and between consecutive years are eliminated to a large extent with the rate adjustment method developed by conducting simulations with many scenarios.

Chart 3: Cumulative Loss Costs in Hierarchical Geographic Area

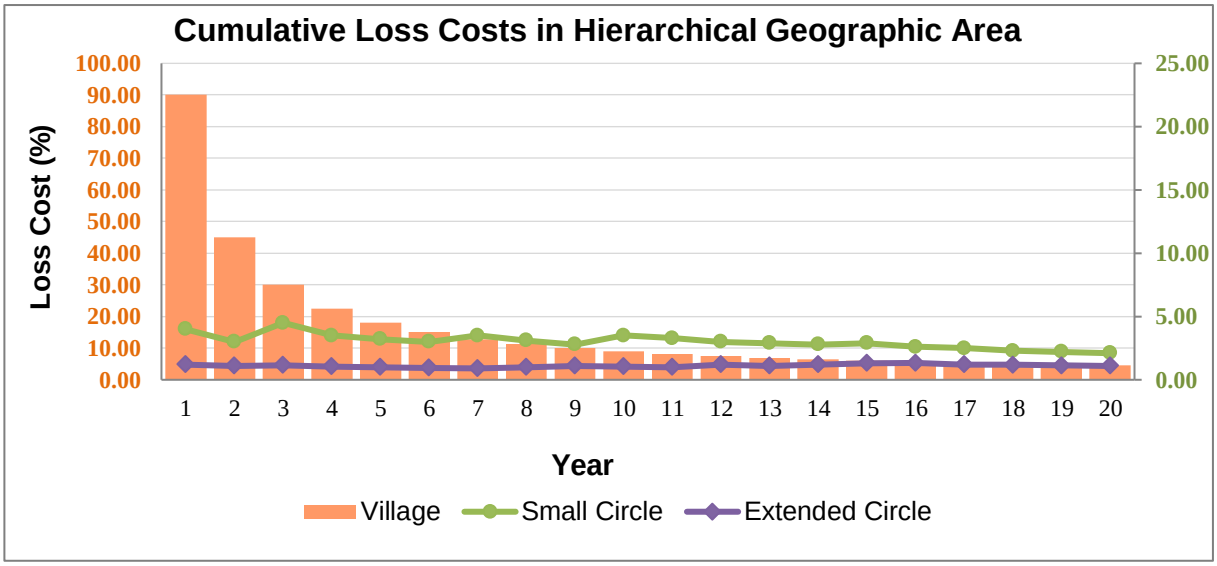
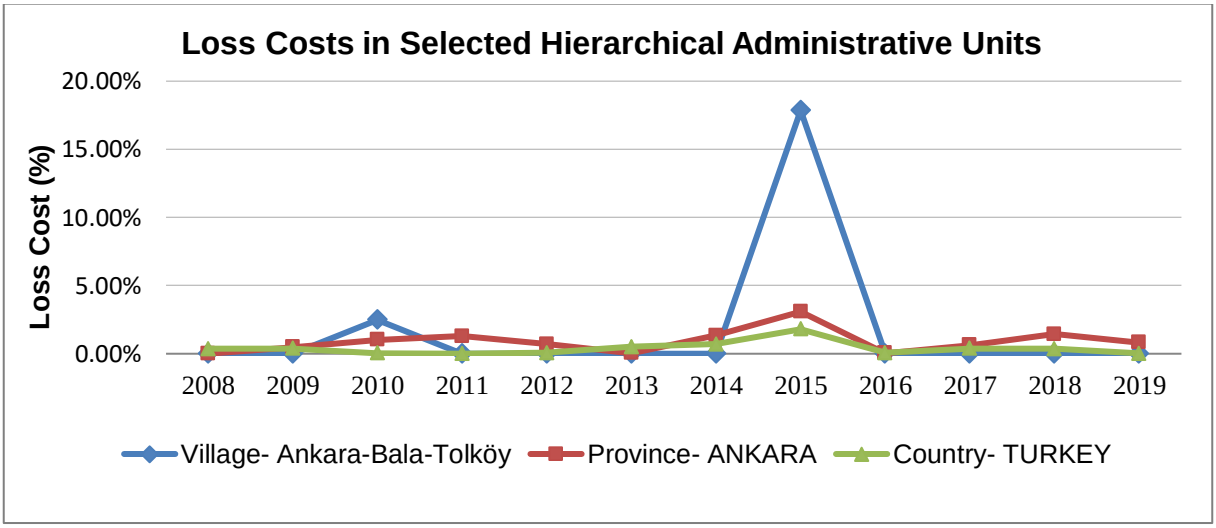


Chart 4: Loss Costs in Selected Hierarchical Administrative Units



The main stages of the village-based rate adjustment method are given below:

I. Establishment of the hierarchical geographic units
II. Weighting the loss costs of the hierarchical geographic units
III. Determining the target loss ratio of the portfolio
IV. Calculation of the required premium rates for the villages
V. Setting the final premium rates for the villages to be applied

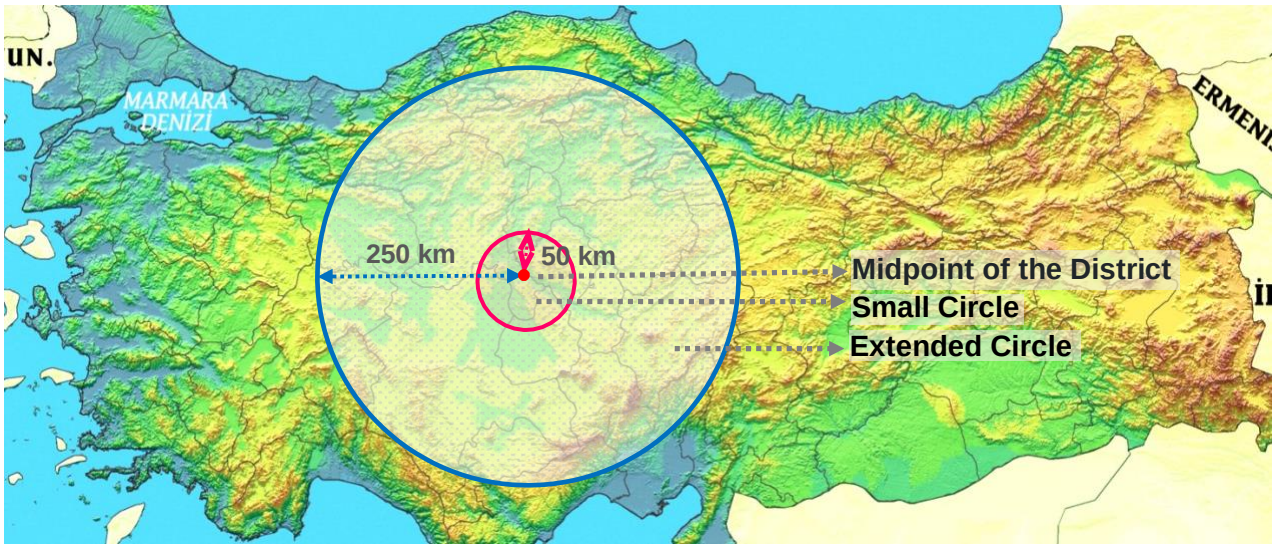
I. Establishment of Hierarchical Geographic Units: One of the components of this method are hierarchical geographic units. The rationale behind this is to normalize the extreme loss costs of villages that may occur in the short term and to smooth the loss costs of the villages by sharing the loss costs of wider geographic areas at a certain level. In this context, hierarchical geographic units were established with concentric circles, as in Table 9.

Table 9: Definition of Hierarchical Geographic Units

Geographic Unit	Radius
Village	Village
Small Circle	30–60 km
Extended Circle	200–400 km

Ideally, the middle point of the villages as centre of concentric circles should be preferred. However, it might be difficult since there are too many villages. Therefore, the middle point of the districts can be used for concentric circles instead whereas the size of the circle should be large enough to cover all villages belonging to the largest district in a given country. An example of the concentric circles is illustrated in Figure 6.

Figure 6: Visual Representations of the Foreseen Concentric Circles



By using GIS, the aggregated amount of sum insured and losses from the small circles and extended circles are calculated. A sample for datasheet of the loss costs of each geographic unit is shown in Tables 10–11.

Table 10: A Sample Data Sheet for the Loss Costs of the Small Circles

Year	Small Circle (Bünyan)	Crop Type	Premium	Sum Insured	Loss[10]	Loss Cost (%)
2001	r= 50 km	Wheat	0	0	0	0.00
2002			0	0	0	0.00
2003			0	0	0	0.00
2004			17,037	851,852	156,520	18.37
2005			24,091	1,120,532	0	0.00
2006			23,026	1,070,987	0	0.00
2007			24,768	1,152,006	90,510	7.86
2008			27,157	1,263,120	79,432	6.29
2009			28,562	1,328,450	0	0.00
Cumulative			**144,641**	**6,786,947**	**326,462**	**4.81**

Table 11: A Sample Data Sheet for the Loss Cost of the Extended Circles

Year	Extended Circle (Bünyan)	Crop Type	Premium	Sum Insured	Loss	Loss Cost (%)
2001	r =250 km	Wheat	122,551	6,127,544	123,903	2.02
2002			131,437	6,571,849	125,092	1.90
2003			144,369	7,218,444	214,080	2.97
2004			149,926	7,496,298	247,300	3.30
2005			226,460	10,533,001	348,300	3.31
2006			221,052	10,281,475	0	0.00
2007			247,681	11,520,060	209,830	1.82
2008			282,434	13,136,448	307,500	2.34
2009			314,178	14,612,950	0	0.00
Cumulative			**1,840,088**	**87,498,069**	**1,576,005**	**1.80**

II. Weighting of the Loss Costs of Hierarchical Geographic Units: Spatial and temporal smoothing of loss costs of the villages plays a crucial role in this method. In this context, weighting factors of the geographic units should be determined in such a way that the difference in loss costs between neighboring villages can be kept at a rather low level as there will be no large difference in the long term. This can be achieved by assigning the lowest weighting factors for villages and a relatively higher factor for the small circles in the early years of insurance in villages. The length of the insurance records of the villages was used as a reference for weighting factors in the rate adjustment method. Weighting factors of the villages and the small centers should be increased gradually over time to reach balanced premium rates. The weighting factor of the extended circle is kept flat. Thus, smoothing the premium rates will be much more efficient.

[10] Historical claims data need to be standardized first in removing features that reduced losses in the past including deductibles, hail nets so that all historical loss costs are on a common basis.

The weighting factors of the loss costs of the hierarchical geographic units and the weight of the current premium rate of the village determined are shown in Table 12.

Table 12: Weighting Factors of the Loss Costs of the and Current Premium Rates

Geographic Unit	Weighting Factor (%)
Loss Cost of the Village	A
Loss Cost of Small Circle	10 + 2A
Loss Cost of the Extended Circle	30
Current Premium Rate of the Village	60 - 3A

A: Length of Insurance records of the village (year)

The weighting factors determined for the loss costs of the hierarchical geographic units and the weighting factors of the current premium rates according to the different length of insurance records for a village are shown in Table 13.

Table 13: Examples of the Weighting Factors for Different Length of the Insurance Records

Geographic Unit	Weighted	Weighting Factor (%)	Length of the Insurance Record of Village (year) and Weighting Factors(%)				
			0	1	5	10	≥20
Village	Loss Cost	A	0	1	5	10	20
Small Circles	Loss Cost	10 + 2A	10	12	20	30	50
Extended Circles	Loss Cost	30	30	30	30	30	30
Village	Current Premium Rate of the Village	60 - 3A	60	57	45	30	0

In terms of smoothing village loss costs, the author considered the above factors the best one out of many simulated in the several scenarios, including extreme ones. In establishing the weighting factors, how loss costs of the hierarchical geographic circles affect a village's loss cost was taken into account. The logic behind this is that the more geographical area is included in the insurance record and the longer the insurance record is, the more it balances out the loss cost to the village. Accordingly, based on the length of the insurance record of villages, weighting factors for the small circle and the extended circle were established. Table 14 shows the application of weighting factors to the hierarchical geographic units. For the purposes of this example, the length of the village's insurance record is considered to be 6 years (A = 6).

Table 14: Calculation of the Weighted Loss Cost in the Hierarchical Geographic Units

Hierarchical Geographic Unit	Loss Cost (%)		Weight (%)		Weighted Loss Cost (%)
Village	**5.0**	X	**6** (A)	=	**0.30**
					+
Small Circle	**2.9**	X	**22** (2A + 10)	=	**0.64**
					+
Extended Circle	**1.1**	X	**30**	=	**0.33**

When the required premium rate is calculated, weighted loss cost of the hierarchical geographic units is divided by Target Loss Ratio as will be seen in Table 15.

The weighting of the village's current premium rate is also a component of the rate adjustment method so that premium rates can be adjusted smoothly over time. Table 15 gives an example of how to calculate the required premium rate for the above village.

Table 15: Calculation of the Required Premium Rates in Crop-Hail Insurance

Geographic Hierarchical Unit	Loss Cost (%)		Target Loss Ratio		Weight (%)		Weighted Premium Rate (%)
Village	**5.00**	**/**	**60**	**X**	**6 (A)**	**=**	**0.50**
							+
Small Circle	**2.90**	**/**	**60**	**X**	**22 (2A + 10)**	**=**	**1.06**
							+
Extended Circle	**1.10**	**/**	**60**	**X**	**30**	**=**	**0.55**
							+
Current Premium Rate of the Village (2.00%)				**X**	**42 (60 - 3A)**	**=**	**0.84**
							=
Required Premium Rate of Village - Crop (%)						**=**	**2.95**

In the end, spatial smoothing makes it possible to calculate the portfolio's lowest and highest premium rates automatically. The outcomes of implementing these weighting factors with different scenarios, including extreme cases, are present in the appendices.

III. The Determination of the Target Loss Ratio: The Target Loss Ratio plays an important role in the determination of accurate premium rates. The target loss ratio is calculated as shown in the formula below:

Y	=	Expected Premium Load (%)
100	=	Policy Premium (%)
Target Loss Ratio (%)	=	(100–Y)/100

The "Safety Margin", another loading component, consists of a few factors such as moral risk adverse selection, late payment of premiums, unexpected severe damage, and capital charges of the insurer and plays an important role when determining the policy premium. Because of the high uncertainty of hail frequency in the early stages of the crop-hail insurance program, the safety margin should be kept higher than normal, and it should be gradually reduced over time. An example of using the safety margin and other loading factors in the early years of the crop-hail insurance scheme is seen in Table 16. Loading factors, including safety margin, can vary depending on the country's conditions.

Table 16: An Example of Loading Factors in Early Stage of a Crop-Hail Insurance Scheme

Length of Insurance Records (year)	Loading Factors[11]						Expected Total Premium Load (Y)	Target LR (%) (100-Y) /100
	Admin Costs / Premium	Commission / Premium	Loss Adjustment Expenses / Premium	Reinsurance Cost / Premium	Safety Margin/ Premium	Profit / Premium		
1	5.0%	13.0%	5.0%	10.0%	12.0%	5.0%	50.0%	50%
2	4.5%	13.0%	4.9%	9.8%	11.5%	5.0%	48.7%	51%
3	4.0%	13.0%	4.8%	9.6%	11.0%	5.0%	47.4%	53%
4	3.5%	13.0%	4.7%	9.4%	10.5%	5.0%	46.1%	54%
5	3.0%	13.0%	4.6%	9.2%	10.0%	5.0%	44.8%	55%
6	2.5%	13.0%	4.5%	9.0%	9.5%	5.0%	43.5%	57%
7	2.0%	13.0%	4.4%	8.8%	9.0%	5.0%	42.2%	58%
8	2.0%	13.0%	4.3%	8.6%	8.5%	5.0%	41.4%	59%
9	2.0%	13.0%	4.2%	8.4%	8.0%	5.0%	40.6%	59%
10	2.0%	13.0%	4.1%	8.2%	7.5%	5.0%	39.8%	60%

During the first few years of the insurance program, extreme hail losses will have a high impact on the loss cost. The direct effects of this loss on a policy's premium rates will cause an unaffordable premium rate level the following year. Similarly, administration and claims handling costs are also higher during the early phases of an insurance program. Moreover, if a relatively higher discount is applied for claims-free policies, additional loading will be needed. The above factors must be taken into account when calculating the target loss ratio for villages, since the required rates for villages are largely based on this measurement.

IV. Calculation of the Required Premium for the Village: As mentioned before, when the required village premium rate is calculated, the cumulative loss costs of the hierarchical units are multiplied by their weighting factors and divided by the target loss ratio. The village's current premium rate is also included in the rate adjustment method so that the premium rates, which are considered high or low according to the available insurance data can be adjusted smoothly within a few years. Some examples of the calculation of the required premium rates for villages with different length of insurance records are shown in Table 17.

Table 17: Examples of Required Premium Rates Calculated on a Village - Crop Basis

Village	Crop Type	Length of the Insurance Record of Village (year)	Loss Cost of the Village	Weight of Village (A)	Loss Cost of Small Circle	Weight of Small Circle (2A + 10)	Loss Cost of Extended Circle	Weight of Extended Circle (30)	Target Loss Ratio	Current Premium Rate of the Village	Weight of the Current Premium Rate (60 - 3A)	Required Premium Rate	Change Between Current and Required Premium Rates
Taşlı	Wheat	0	0.0%	0.0%	1.0%	10.0%	0.9%	30%	60%	1.50%	60.00%	1.12%	-25%
Tuzla	Wheat	1	40.0%	1.0%	1.0%	12.0%	0.9%	30%	60%	1.40%	57.00%	1.27%	-9%
Kale	Wheat	2	30.0%	2.0%	1.0%	14.0%	0.9%	30%	60%	1.60%	54.00%	1.47%	-8%
İğdeli	Wheat	3	20.0%	3.0%	1.0%	16.0%	0.9%	30%	60%	1.30%	51.00%	1.28%	-1%
Akçay	Wheat	4	10.0%	4.0%	1.0%	18.0%	0.9%	30%	60%	1.35%	48.00%	1.16%	-14%
Kıyı	Wheat	5	5.0%	5.0%	1.0%	20.0%	0.9%	30%	60%	1.50%	45.00%	1.11%	-26%
Kaya	Wheat	6	4.0%	6.0%	1.0%	22.0%	0.9%	30%	60%	1.45%	42.00%	1.05%	-28%
Alaca	Wheat	7	2.0%	7.0%	1.0%	24.0%	0.9%	30%	60%	1.60%	39.00%	1.01%	-37%
Akça	Wheat	8	3.0%	8.0%	1.0%	26.0%	0.9%	30%	60%	2.00%	36.00%	1.18%	-41%
Dereli	Wheat	9	2.0%	9.0%	1.0%	28.0%	0.9%	30%	60%	2.50%	33.00%	1.26%	-49%

A: Length of the insurance records of the village

[11] All loading factors need to be determined according to country specific conditions before rate adjustment work

V. Setting of the Final Premium Rates for the Villages: Under the adjustment method, the required premium rates of a village for a given crop may be too high in comparison to the current premium rates. It is therefore necessary to limit the change in the premium rate by a certain percentage (e.g. -10% and +20%) as illustrated in Table 18. The difference between the required premium rate and the current premium rate for villages is partly compensated by the rate adjustments made on a parcel basis, as explained later. Thus, premium rates will smoothly reach a reasonable level within a few years. However, the range of these limits may be widened or removed, depending on the urgency to improve premium rates.

Table 18: Calculation of the Final Premium Rates of the Villages

Current Premium Rate(%)	Required Premium Rate (%)	Difference Between Current Premium and Required Premium Rate	Premium Rate to be Applied[12] (%)
2.00	1.00	**-50%**	**1.80**
2.00	1.25	**-38%**	**1.80**
2.00	1.50	**-25%**	**1.80**
2.00	1.85	-8%	1.85
2.00	2.00	0%	2.00
2.00	2.20	10%	2.20
2.00	2.50	25%	2.50
2.00	2.70	35%	2.70
2.00	3.00	**50%**	**2.80**
2.00	4.00	**100%**	**2.80**

Using this method will provide the following benefits:

- Smoothing the lost costs of villages, thus avoiding the big differences between neighboring villages
- Increasing the credibility of loss costs of the villages
- Converting the loss costs of "0" (non-damaged) villages to reasonable premium rates
- Establishment of the lowest and highest premium rates countrywide automatically
- Avoiding adverse selection
- Stabilizing premium rates (prevents huge increases in rates)

PARCEL-BASED PREMIUM RATE ADJUSTMENT PLAN

The premium rates calculated on a village basis cannot be applied to all parcels in the village, since hail impact may vary enormously in terms of frequency and severity within a small geographical area. In other words, the damage history of the same crop type may vary in different parcels in the same village. For this reason, necessary adjustments must be made to the premium rates which were determined based on the village, within the framework of the plan annually. While this practice is an incentive for the farmers who own the undamaged parcels to continue to purchase insurance, it also ensures the financial sustainability of the system by making the load according to the average loss ratio of the parcels. For this purpose, the rate adjustment plan envisaged is shown in Table 19. This plan can work very well with today's information technology in all countries as all information can be provided and be kept track for many years even if the parcel is subleased or sold to other farmers. The only problem that may arise is if a parcel is insured by another insurance company.

[12] Premium rate increase is limited to +40% and premium rate decrease is limited to (-20%) of the current premium rate

Table 19: Parcel-Crop Type Based Annual Rate Adjustment Plan

Loss Ratio Category	Average Loss Ratio ALR (%)	Change to Be Done in Premium Rate (%)
A (discounting)	0.00%	LIR* x (-2)
B (discounting)	0.01–29.99%	(ALR** x 0.011–0.511) x LIR
C (no adjustment)	30.00–99.99%	0
D (loading)	≥ 100%	LIR x ALR /200

* LIR: Length of Insurance Record in the Parcel (year)
** ALR: Average Loss Ratio

The above plan was formulated by considering the minimum and maximum changes to be made in each category of the loss ratio. The factors used in this plan were determined in a way that the projected change can be obtained for each loss ratio category.

It is envisaged that the highest reduction will be limited to 20% and the highest increase will be limited to 40% of the current village crop premium rate. While preparing the rate adjustment plan, the issue to be considered is balancing the average loss ratio of the total portfolio. When this rate adjustment plan is applied, premium rate changes to be made to the selected average loss ratio categories are shown in Table 20.

This rate adjustment plan relies on the assumption that the sum of all discounts and loading should be as close to "0" as possible. Based on the average loss ratio of the recent portfolios and its comparison to the target loss ratio, the plan must be revised according to the results of the simulation to be conducted with actual insurance data. In this context, it may be appropriate to rethink primarily claims-free discounts in particular. Annual claims-free discount may be determined between 1% and 5% according to the result of the simulation.

Table 20: Example of Parcel-Crop Type Basis Annual Rate Adjustment Plan

Loss Ratio Category	Average Loss Ratio of the Parcel (%)	Length of Insurance Record and Change to Be Done to the Premium Rate (%)									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	**0**	-5	-10	-15	-20	-20	-20	-20	-20	-20	-20
B	**1**	-0.50	-1.00	-1.50	-2.00	-2.50	-3.00	-3.50	-4.00	-4.50	-5.00
	10	-0.40	-0.80	-1.20	-1.60	-2.01	-2.41	-2.81	-3.21	-3.61	-4.01
	20	-0.29	-0.58	-0.87	-1.16	-1.46	-1.75	-2.04	-2.33	-2.62	-2.91
	29	-0.19	-0.38	-0.58	-0.77	-0.96	-1.15	-1.34	-1.54	-1.73	-1.92
C	**30–99**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
D	**100**	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
	500	2.50	5.00	7.50	10.00	12.50	15.00	17.50	20.00	22.50	25.00
	2000	10	20	30	40	40	40	40	40	40	40
	4000	20	40	40	40	40	40	40	40	40	40

In addition to the adjustment on parcel basis, as a final note, it is no need to mention that premium rates must be reduced when the insured has loss mitigation measures including hail nets.

CONCLUSION

To predict the long-term loss costs of the villages and to determine the premium rates as accurately as possible, the author has used the length of the insurance records of villages and loss costs of hierarchical geographical units in the rate adjustment method. For this purpose, the author used the village as a basic rating unit and weighted the loss costs of the hierarchical geographic units established as concentric circles with different degrees. As the length of the insurance record increases, the accuracy of the premium rates also increases.

The author has also proposed a parcel-based rate adjustment plan for fine-tuning. For this purpose, he has used the average loss ratio of parcels and the length of the insurance records.

The following benefits are expected from this adjustment method and plan soon:

- The required premiums rates will be automatically and objectively determined.
- The premium rates calculated will be balanced, fair, and affordable within a few years.
- The lowest and highest premium rates of the portfolio will be established automatically.
- The portfolio's target loss ratio will be approached after a few years.
- Purchasing insurance will be encouraged for farmers with a claims-free discounts.
- Adverse selection will be prevented by applying the appropriate premium rate in high-risk areas.
- Between neighboring villages, large differences in premium rates will be reduced.
- Farmers will feel confident about the rating system.
- There will be a positive effect on insurance penetration.

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APPENDICES

APPENDIX 1

Examples of Premium Rate Calculations on Village Basis with Short-Term Insurance Data for Different Scenarios
Case 1: Length of Insurance Record of the Village: 0 Year

Scenario	Crop Type	Length of Insurance Records (**A**)	Weight of Village **(A)**	Loss Cost of the Village	Weight of Small Circle **(2A+10)**	Loss Cost of Small Circle	Weight of Extended Circle **(30)**	Loss Cost of Extended Circle	Target Loss Ratio	Current Premium Rate of the Village	Weight of the Current Premium Rate **(60 - 3A)**	Required Premium Rate	Difference Between Current Premium and Required Premium Rate*	Premium Rate to Be Applied
1	Wheat	0	0%	**0%**	10%	**0.0%**	30.0%	**1.00%**	60%	0.5%	60%	**0.80%**	**60%**	**0.60%**
2	Wheat	0	0%	**0%**	10%	**0.5%**	30.0%	**1.00%**	60%	0.5%	60%	**0.88%**	**77%**	**0.60%**
3	Wheat	0	0%	**0%**	10%	**1.0%**	30.0%	**1.00%**	60%	0.5%	60%	**0.97%**	**93%**	**0.60%**
4	Wheat	0	0%	**0%**	10%	**2.0%**	30.0%	**1.00%**	60%	0.5%	60%	**1.13%**	**127%**	**0.60%**
5	Wheat	0	0%	**0%**	10%	**3.0%**	30.0%	**1.00%**	60%	0.5%	60%	**1.30%**	**160%**	**0.60%**
6	Wheat	0	0%	**0%**	10%	**4.0%**	30.0%	**1.00%**	60%	0.5%	60%	**1.47%**	**193%**	**0.45%**
7	Wheat	0	0%	**0%**	10%	**0.0%**	30.0%	**1.00%**	60%	1.0%	60%	1.10%	10%	1.10%
8	Wheat	0	0%	**0%**	10%	**0.5%**	30.0%	**1.00%**	60%	1.0%	60%	1.18%	18%	1.18%
9	Wheat	0	0%	**0%**	10%	**1.0%**	30.0%	**1.00%**	60%	1.0%	60%	**1.27%**	**27%**	**1.20%**
10	Wheat	0	0%	**0%**	10%	**2.0%**	30.0%	**1.00%**	60%	1.0%	60%	**1.43%**	**43%**	**1.20%**
11	Wheat	0	0%	**0%**	10%	**3.0%**	30.0%	**1.00%**	60%	1.0%	60%	**1.60%**	**60%**	**1.20%**
12	Wheat	0	0%	**0%**	10%	**4.0%**	30.0%	**1.00%**	60%	1.0%	60%	**1.77%**	**77%**	**1.20%**
13	Wheat	0	0%	**0%**	10%	**0.0%**	30.0%	**1.00%**	60%	2.0%	60%	**1.70%**	**-15%**	**2.40%**
14	Wheat	0	0%	**0%**	10%	**0.5%**	30.0%	**1.00%**	60%	2.0%	60%	**1.78%**	**-11%**	**2.40%**
15	Wheat	0	0%	**0%**	10%	**1.0%**	30.0%	**1.00%**	60%	2.0%	60%	1.87%	-7%	1.87%
16	Wheat	0	0%	**0%**	10%	**2.0%**	30.0%	**1.00%**	60%	2.0%	60%	2.03%	2%	2.03%
17	Wheat	0	0%	**0%**	10%	**3.0%**	30.0%	**1.00%**	60%	2.0%	60%	2.20%	10%	2.20%
18	Wheat	0	0%	**0%**	10%	**4.0%**	30.0%	**1.00%**	60%	2.0%	60%	2.37%	18%	2.37%
19	Wheat	0	0%	**0%**	10%	**0.0%**	30.0%	**1.00%**	60%	3.0%	60%	**2.30%**	**-23%**	**3.60%**
20	Wheat	0	0%	**0%**	10%	**0.5%**	30.0%	**1.00%**	60%	3.0%	60%	**2.38%**	**-21%**	**3.60%**
21	Wheat	0	0%	**0%**	10%	**1.0%**	30.0%	**1.00%**	60%	3.0%	60%	**2.47%**	**-18%**	**2.70%**
22	Wheat	0	0%	**0%**	10%	**2.0%**	30.0%	**1.00%**	60%	3.0%	60%	**2.63%**	**-12%**	**2.70%**
23	Wheat	0	0%	**0%**	10%	**3.0%**	30.0%	**1.00%**	60%	3.0%	60%	2.80%	-7%	2.80%
24	Wheat	0	0%	**0%**	10%	**4.0%**	30.0%	**1.00%**	60%	3.0%	60%	2.97%	-1%	2.97%

A: Length of Insurance records of the village

***** Premium rate increase is limited to 20% and premium rate decrease is limited to (-10%) of the current premium rate

APPENDIX 2

Examples of Premium Rate Calculations on Village Basis with Short-Term Insurance Data for Different Scenarios
Case 2: Length of Insurance Record of the Village – 1 year

Scenario	Crop Type	Length of Insurance Records (**A**)	Weight of Village **(A)**	Loss Cost of the Village	Weight of Small Circle **(2A+10)**	Loss Cost of Small Circle	Weight of Extended Circle **(30)**	Loss Cost of Extended Circle	Target Loss Ratio	Current Premium Rate of the Village	Weight of the Current Premium Rate **(60 - 3A)**	Required Premium Rate	Difference Between Current Premium and Required Premium Rate*	Premium Rate to Be Applied
1	Wheat	1	1%	0%	12%	**0.5%**	30.0%	**1.00%**	60%	1.0%	57%	1.17%	17%	1.17%
2	Wheat	1	1%	10%	12%	**0.5%**	30.0%	**1.00%**	60%	1.0%	57%	**1.34%**	**34%**	1.20%
3	Wheat	1	1%	20%	12%	**0.5%**	30.0%	**1.00%**	60%	1.0%	57%	**1.50%**	**50%**	1.20%
4	Wheat	1	1%	30%	12%	**0.5%**	30.0%	**1.00%**	60%	1.0%	57%	**1.67%**	**67%**	1.20%
5	Wheat	1	1%	50%	12%	**0.5%**	30.0%	**1.00%**	60%	1.0%	57%	**2.00%**	**100%**	1.20%
6	Wheat	1	1%	100%	12%	**0.5%**	30.0%	**1.00%**	60%	1.0%	57%	**2.84%**	**184%**	1.20%
7	Wheat	1	1%	**0%**	12%	**1.0%**	30.0%	**1.00%**	60%	2.0%	57%	1.84%	-8%	1.84%
8	Wheat	1	1%	10%	12%	**1.0%**	30.0%	**1.00%**	60%	2.0%	57%	2.01%	0%	2.01%
9	Wheat	1	1%	20%	12%	**1.0%**	30.0%	**1.00%**	60%	2.0%	57%	2.17%	9%	2.17%
10	Wheat	1	1%	30%	12%	**1.0%**	30.0%	**1.00%**	60%	2.0%	57%	2.34%	17%	2.34%
11	Wheat	1	1%	50%	12%	**1.0%**	30.0%	**1.00%**	60%	2.0%	57%	**2.67%**	**34%**	2.40%
12	Wheat	1	1%	100%	12%	**1.0%**	30.0%	**1.00%**	60%	2.0%	57%	**3.51%**	**75%**	2.40%
13	Wheat	1	1%	0%	12%	**2.0%**	30.0%	**1.00%**	60%	3.0%	57%	**2.61%**	**-13%**	2.70%
14	Wheat	1	1%	10%	12%	**2.0%**	30.0%	**1.00%**	60%	3.0%	57%	2.78%	-7%	2.78%
15	Wheat	1	1%	20%	12%	**2.0%**	30.0%	**1.00%**	60%	3.0%	57%	2.94%	-2%	2.94%
16	Wheat	1	1%	30%	12%	**2.0%**	30.0%	**1.00%**	60%	3.0%	57%	3.11%	4%	3.11%
17	Wheat	1	1%	50%	12%	**2.0%**	30.0%	**1.00%**	60%	3.0%	57%	3.44%	15%	3.44%
18	Wheat	1	1%	100%	12%	**2.0%**	30.0%	**1.00%**	60%	3.0%	57%	**4.28%**	**43%**	3.60%
19	Wheat	1	1%	**0%**	12%	**4.0%**	30.0%	**1.00%**	60%	4.0%	57%	**3.58%**	**-11%**	3.60%
20	Wheat	1	1%	10%	12%	**4.0%**	30.0%	**1.00%**	60%	4.0%	57%	3.75%	-6%	3.75%
21	Wheat	1	1%	20%	12%	**4.0%**	30.0%	**1.00%**	60%	4.0%	57%	3.91%	-2%	3.91%
22	Wheat	1	1%	30%	12%	**4.0%**	30.0%	**1.00%**	60%	4.0%	57%	4.08%	2%	4.08%
23	Wheat	1	1%	50%	12%	**4.0%**	30.0%	**1.00%**	60%	4.0%	57%	4.41%	10%	4.41%
24	Wheat	1	1%	100%	12%	**4.0%**	30.0%	**1.00%**	60%	4.0%	57%	**5.25%**	**31%**	4.80%

A: Length of Insurance records of the village

***** Premium rate increase is limited to 20% and premium rate decrease is limited to (-10%) of the current premium rate

APPENDIX 3

Examples of Premium Rate Calculations on Village Basis with Short-Term Insurance Data for Different Scenarios
Case 3: Length of Insurance Record of the Village – 2 years

Scenario	Crop Type	Length of Insurance Records (**A**)	Weight of Village **(A)**	Loss Cost of the Village	Weight of Small Circle **(2A+10)**	Loss Cost of Small Circle	Weight of Extended Circle **(30)**	Loss Cost of Extended Circle	Target Loss Ratio	Current Premium Rate of the Village	Weight of the Current Premium Rate **(60 - 3A)**	Required Premium Rate	Difference Between Current Premium and Required Premium Rate*	Premium Rate to Be Applied
1	Wheat	2	2%	**0%**	14%	**0.5%**	30.0%	**1.00%**	60%	1.0%	54%	1.16%	16%	1.16%
2	Wheat	2	2%	**10%**	14%	**0.5%**	30.0%	**1.00%**	60%	1.0%	54%	**1.49%**	**49%**	1.20%
3	Wheat	2	2%	**20%**	14%	**0.5%**	30.0%	**1.00%**	60%	1.0%	54%	**1.82%**	**82%**	1.20%
4	Wheat	2	2%	**30%**	14%	**0.5%**	30.0%	**1.00%**	60%	1.0%	54%	**2.16%**	**116%**	1.20%
5	Wheat	2	2%	**40%**	14%	**0.5%**	30.0%	**1.00%**	60%	1.0%	54%	**2.49%**	**149%**	1.20%
6	Wheat	2	2%	**50%**	14%	**0.5%**	30.0%	**1.00%**	60%	1.0%	54%	**2.82%**	**182%**	1.20%
7	Wheat	2	2%	**0%**	14%	**1.0%**	30.0%	**1.00%**	60%	2.0%	54%	1.81%	-9%	1.81%
8	Wheat	2	2%	**10%**	14%	**1.0%**	30.0%	**1.00%**	60%	2.0%	54%	2.15%	7%	2.15%
9	Wheat	2	2%	**20%**	14%	**1.0%**	30.0%	**1.00%**	60%	2.0%	54%	**2.48%**	**24%**	2.40%
10	Wheat	2	2%	**30%**	14%	**1.0%**	30.0%	**1.00%**	60%	2.0%	54%	**2.81%**	**41%**	2.40%
11	Wheat	2	2%	**40%**	14%	**1.0%**	30.0%	**1.00%**	60%	2.0%	54%	**3.15%**	**57%**	2.40%
12	Wheat	2	2%	**50%**	14%	**1.0%**	30.0%	**1.00%**	60%	2.0%	54%	**3.48%**	**74%**	2.40%
13	Wheat	2	2%	**0%**	14%	**2.0%**	30.0%	**1.00%**	60%	3.0%	54%	**2.59%**	**-14%**	2.70%
14	Wheat	2	2%	**10%**	14%	**2.0%**	30.0%	**1.00%**	60%	3.0%	54%	2.92%	-3%	2.92%
15	Wheat	2	2%	**20%**	14%	**2.0%**	30.0%	**1.00%**	60%	3.0%	54%	3.25%	8%	3.25%
16	Wheat	2	2%	**30%**	14%	**2.0%**	30.0%	**1.00%**	60%	3.0%	54%	**3.59%**	**20%**	3.60%
17	Wheat	2	2%	**40%**	14%	**2.0%**	30.0%	**1.00%**	60%	3.0%	54%	**3.92%**	**31%**	3.60%
18	Wheat	2	2%	**50%**	14%	**2.0%**	30.0%	**1.00%**	60%	3.0%	54%	**4.25%**	**42%**	3.60%
19	Wheat	2	2%	**0%**	14%	**4.0%**	30.0%	**1.00%**	60%	4.0%	54%	**3.59%**	**-10.2%**	3.60%
20	Wheat	2	2%	**10%**	14%	**4.0%**	30.0%	**1.00%**	60%	4.0%	54%	3.93%	-2%	3.93%
21	Wheat	2	2%	**20%**	14%	**4.0%**	30.0%	**1.00%**	60%	4.0%	54%	4.26%	6%	4.26%
22	Wheat	2	2%	**30%**	14%	**4.0%**	30.0%	**1.00%**	60%	4.0%	54%	4.59%	15%	4.59%
23	Wheat	2	2%	**40%**	14%	**4.0%**	30.0%	**1.00%**	60%	4.0%	54%	**4.93%**	**23%**	4.80%
24	Wheat	2	2%	**50%**	14%	**4.0%**	30.0%	**1.00%**	60%	4.0%	54%	**5.26%**	**32%**	4.80%

A: Length of Insurance records of the village

***** Premium rate increase is limited to 20% and premium rate decrease is limited to (-10%) of the current premium rate

APPENDIX 4

Examples of Premium Rate Calculations on Village Basis with Short-Term Insurance Data for Different Scenarios
Case 4: Length of Insurance Record of the Village – 5 years

Scenario	Crop Type	Length of Insurance Records (**A**)	Weight of Village **(A)**	Loss Cost of the Village	Weight of Small Circle **(2A+10)**	Loss Cost of Small Circle	Weight of Extended Circle **(30)**	Loss Cost of Extended Circle	Target Loss Ratio	Current Premium Rate of the Village	Weight of the Current Premium Rate **(60 - 3A)**	Required Premium Rate	Difference Between Current Premium and Required Premium Rate*	Premium Rate to Be Applied
1	Wheat	5	5%	**0%**	20%	**0.5%**	30.0%	1.00%	60%	1.0%	45%	1.12%	12%	1.12%
2	Wheat	5	5%	**2%**	20%	**0.5%**	30.0%	1.00%	60%	1.0%	45%	**1.28%**	**28%**	**1.20%**
3	Wheat	5	5%	**5%**	20%	**0.5%**	30.0%	1.00%	60%	1.0%	45%	**1.53%**	**53%**	**1.20%**
4	Wheat	5	5%	**10%**	20%	**0.5%**	30.0%	1.00%	60%	1.0%	45%	**1.95%**	**95%**	**1.20%**
5	Wheat	5	5%	**15%**	20%	**0.5%**	30.0%	1.00%	60%	1.0%	45%	**2.37%**	**137%**	**1.20%**
6	Wheat	5	5%	**20%**	20%	**0.5%**	30.0%	1.00%	60%	1.0%	45%	**2.78%**	**178%**	**1.20%**
7	Wheat	5	5%	**0%**	20%	**1.0%**	30.0%	1.00%	60%	2.0%	45%	**1.73%**	**-13%**	**2.40%**
8	Wheat	5	5%	**2%**	20%	**1.0%**	30.0%	1.00%	60%	2.0%	45%	1.90%	-5%	1.90%
9	Wheat	5	5%	**5%**	20%	**1.0%**	30.0%	1.00%	60%	2.0%	45%	2.15%	8%	2.15%
10	Wheat	5	5%	**10%**	20%	**1.0%**	30.0%	1.00%	60%	2.0%	45%	**2.57%**	**28%**	**2.40%**
11	Wheat	5	5%	**15%**	20%	**1.0%**	30.0%	1.00%	60%	2.0%	45%	**2.98%**	**49%**	**2.40%**
12	Wheat	5	5%	**20%**	20%	**1.0%**	30.0%	1.00%	60%	2.0%	45%	**3.40%**	**70%**	**2.40%**
13	Wheat	5	5%	**0%**	20%	**2.0%**	30.0%	1.00%	60%	3.0%	45%	**2.52%**	**-16%**	**3.60%**
14	Wheat	5	5%	**2%**	20%	**2.0%**	30.0%	1.00%	60%	3.0%	45%	**2.68%**	**-11%**	**3.60%**
15	Wheat	5	5%	**5%**	20%	**2.0%**	30.0%	1.00%	60%	3.0%	45%	2.93%	-2%	2.93%
16	Wheat	5	5%	**10%**	20%	**2.0%**	30.0%	1.00%	60%	3.0%	45%	3.35%	12%	3.35%
17	Wheat	5	5%	**15%**	20%	**2.0%**	30.0%	1.00%	60%	3.0%	45%	**3.77%**	**26%**	**3.60%**
18	Wheat	5	5%	**20%**	20%	**2.0%**	30.0%	1.00%	60%	3.0%	45%	**4.18%**	**39%**	**3.60%**
19	Wheat	5	5%	**0%**	20%	**4.0%**	30.0%	1.00%	60%	4.0%	45%	3.63%	-9%	3.63%
20	Wheat	5	5%	**2%**	20%	**4.0%**	30.0%	1.00%	60%	4.0%	45%	3.80%	-5%	3.80%
21	Wheat	5	5%	**5%**	20%	**4.0%**	30.0%	1.00%	60%	4.0%	45%	4.05%	1%	4.05%
22	Wheat	5	5%	**10%**	20%	**4.0%**	30.0%	1.00%	60%	4.0%	45%	4.47%	12%	4.47%
23	Wheat	5	5%	**15%**	20%	**4.0%**	30.0%	1.00%	60%	4.0%	45%	**4.88%**	**22%**	**4.80%**
24	Wheat	5	5%	**20%**	20%	**4.0%**	30.0%	1.00%	60%	4.0%	45%	**5.30%**	**33%**	**4.80%**

A: Length of Insurance records of the village

***** Premium rate increase is limited to 20% and premium rate decrease is limited to (-10%) of the current premium rate

APPENDIX 5

Examples of Premium Rate Calculations on Village Basis with Short-Term Insurance Data for Different Scenarios
Case 5: Length of Insurance Record of the Village – 10 years

Scenario	Crop Type	Length of Insurance Records (**A**)	Weight of Village **(A)**	Loss Cost of the Village	Weight of Small Circle **(2A+10)**	Loss Cost of Small Circle	Weight of Extended Circle **(30)**	Loss Cost of Extended Circle	Target Loss Ratio	Current Premium Rate of the Village	Weight of the Current Premium Rate **(60 - 3A)**	Required Premium Rate	Difference Between Current Premium and Required Premium Rate*	Premium Rate to Be Applied
1	Wheat	10	10%	0%	30%	**0.5%**	30.0%	**1.00%**	60%	1.0%	30%	1.05%	5%	1.05%
2	Wheat	10	10%	1%	30%	**0.5%**	30.0%	**1.00%**	60%	1.0%	30%	**1.22%**	**22%**	**1.20%**
3	Wheat	10	10%	2%	30%	**0.5%**	30.0%	**1.00%**	60%	1.0%	30%	**1.38%**	**38%**	**1.20%**
4	Wheat	10	10%	4%	30%	**0.5%**	30.0%	**1.00%**	60%	1.0%	30%	**1.72%**	**72%**	**1.20%**
5	Wheat	10	10%	8%	30%	**0.5%**	30.0%	**1.00%**	60%	1.0%	30%	**2.38%**	**138%**	**1.20%**
6	Wheat	10	10%	15%	30%	**0.5%**	30.0%	**1.00%**	60%	1.0%	30%	**3.55%**	**255%**	**1.20%**
7	Wheat	10	10%	0%	30%	**1.0%**	30.0%	**1.00%**	60%	2.0%	30%	**1.60%**	**-20%**	**2.40%**
8	Wheat	10	10%	1%	30%	**1.0%**	30.0%	**1.00%**	60%	2.0%	30%	**1.77%**	**-12%**	**2.40%**
9	Wheat	10	10%	2%	30%	**1.0%**	30.0%	**1.00%**	60%	2.0%	30%	1.93%	-3%	1.93%
10	Wheat	10	10%	4%	30%	**1.0%**	30.0%	**1.00%**	60%	2.0%	30%	2.27%	13%	2.27%
11	Wheat	10	10%	8%	30%	**1.0%**	30.0%	**1.00%**	60%	2.0%	30%	**2.93%**	**47%**	**2.40%**
12	Wheat	10	10%	15%	30%	**1.0%**	30.0%	**1.00%**	60%	2.0%	30%	**4.10%**	**105%**	**2.40%**
13	Wheat	10	10%	0%	30%	**2.0%**	30.0%	**1.00%**	60%	3.0%	30%	**2.40%**	**-20%**	**2.70%**
14	Wheat	10	10%	1%	30%	**2.0%**	30.0%	**1.00%**	60%	3.0%	30%	**2.57%**	**-14%**	**2.70%**
15	Wheat	10	10%	2%	30%	**2.0%**	30.0%	**1.00%**	60%	3.0%	30%	2.73%	-9%	2.73%
16	Wheat	10	10%	4%	30%	**2.0%**	30.0%	**1.00%**	60%	3.0%	30%	3.07%	2%	3.07%
17	Wheat	10	10%	8%	30%	**2.0%**	30.0%	**1.00%**	60%	3.0%	30%	**3.73%**	**24%**	**3.60%**
18	Wheat	10	10%	15%	30%	**2.0%**	30.0%	**1.00%**	60%	3.0%	30%	**4.90%**	**63%**	**3.60%**
19	Wheat	10	10%	0%	30%	**4.0%**	30.0%	**1.00%**	60%	4.0%	30%	3.70%	-7%	3.70%
20	Wheat	10	10%	1%	30%	**4.0%**	30.0%	**1.00%**	60%	4.0%	30%	3.87%	-3%	3.87%
21	Wheat	10	10%	2%	30%	**4.0%**	30.0%	**1.00%**	60%	4.0%	30%	4.03%	1%	4.03%
22	Wheat	10	10%	4%	30%	**4.0%**	30.0%	**1.00%**	60%	4.0%	30%	4.37%	9%	4.37%
23	Wheat	10	10%	8%	30%	**4.0%**	30.0%	**1.00%**	60%	4.0%	30%	**5.03%**	**26%**	**4.80%**
24	Wheat	10	10%	15%	30%	**4.0%**	30.0%	**1.00%**	60%	4.0%	30%	**6.20%**	**55%**	**4.80%**

A: Length of Insurance records of the village

* Premium rate increase is limited to 20% and premium rate decrease is limited to (-10%) of the current premium rate

APPENDIX 6

Examples of Premium Rate Calculations on Village Basis with Short-Term Insurance Data for Different Scenarios
Case 6: Length of Insurance Record of the Village – 20 years

Scenario	Crop Type	Length of Insurance Records (**A**)	Weight of Village **(A)**	Loss Cost of the Village	Weight of Small Circle **(2A+10)**	Loss Cost of Small Circle	Weight of Extended Circle **(30)**	Loss Cost of Extended Circle	Target Loss Ratio	Current Premium Rate of the Village	Weight of the Current Premium Rate **(60 - 3A)**	Required Premium Rate	Difference Between Current Premium and Required Premium Rate*	Premium Rate to Be Applied
1	Wheat	20	20%	0%	50%	**0.5%**	30.0%	1.00%	60%	1.0%	0%	0.92%	-8%	0.92%
2	Wheat	20	20%	0.5%	50%	**0.5%**	30.0%	1.00%	60%	1.0%	0%	1.08%	8%	1.08%
3	Wheat	20	20%	1.0%	50%	**0.5%**	30.0%	1.00%	60%	1.0%	0%	**1.25%**	**25%**	**1.20%**
4	Wheat	20	20%	2.0%	50%	**0.5%**	30.0%	1.00%	60%	1.0%	0%	**1.58%**	**58%**	**1.20%**
5	Wheat	20	20%	5.0%	50%	**0.5%**	30.0%	1.00%	60%	1.0%	0%	**2.58%**	**158%**	**1.20%**
6	Wheat	20	20%	10.0%	50%	**0.5%**	30.0%	1.00%	60%	1.0%	0%	**4.25%**	**325%**	**1.20%**
7	Wheat	20	20%	0%	50%	**1.0%**	30.0%	1.00%	60%	2.0%	0%	**1.33%**	**-33%**	**1.33%**
8	Wheat	20	20%	0.5%	50%	**1.0%**	30.0%	1.00%	60%	2.0%	0%	**1.50%**	**-25%**	**1.50%**
9	Wheat	20	20%	1.0%	50%	**1.0%**	30.0%	1.00%	60%	2.0%	0%	**1.67%**	**-17%**	**1.67%**
10	Wheat	20	20%	2.0%	50%	**1.0%**	30.0%	1.00%	60%	2.0%	0%	2.00%	0%	2.00%
11	Wheat	20	20%	5.0%	50%	**1.0%**	30.0%	1.00%	60%	2.0%	0%	**3.00%**	**50%**	**2.40%**
12	Wheat	20	20%	10.0%	50%	**1.0%**	30.0%	1.00%	60%	2.0%	0%	**4.67%**	**133%**	**2.40%**
13	Wheat	20	20%	0%	50%	**2.0%**	30.0%	1.00%	60%	3.0%	0%	**2.17%**	**-28%**	**2.17%**
14	Wheat	20	20%	0.5%	50%	**2.0%**	30.0%	1.00%	60%	3.0%	0%	**2.33%**	**-22%**	**2.33%**
15	Wheat	20	20%	1.0%	50%	**2.0%**	30.0%	1.00%	60%	3.0%	0%	**2.50%**	**-17%**	**2.50%**
16	Wheat	20	20%	2.0%	50%	**2.0%**	30.0%	1.00%	60%	3.0%	0%	2.83%	-6%	2.83%
17	Wheat	20	20%	5.0%	50%	**2.0%**	30.0%	1.00%	60%	3.0%	0%	**3.83%**	**28%**	**3.60%**
18	Wheat	20	20%	10.0%	50%	**2.0%**	30.0%	1.00%	60%	3.0%	0%	**5.50%**	**83%**	**3.60%**
19	Wheat	20	20%	0%	50%	**4.0%**	30.0%	1.00%	60%	4.0%	0%	3.83%	-4%	3.83%
20	Wheat	20	20%	0.5%	50%	**4.0%**	30.0%	1.00%	60%	4.0%	0%	4.00%	0%	4.00%
21	Wheat	20	20%	1.0%	50%	**4.0%**	30.0%	1.00%	60%	4.0%	0%	4.17%	4%	4.17%
22	Wheat	20	20%	2.0%	50%	**4.0%**	30.0%	1.00%	60%	4.0%	0%	4.50%	13%	4.50%
23	Wheat	20	20%	5.0%	50%	**4.0%**	30.0%	1.00%	60%	4.0%	0%	**5.50%**	**38%**	**4.80%**
24	Wheat	20	20%	10.0%	50%	**4.0%**	30.0%	1.00%	60%	4.0%	0%	**7.17%**	**79%**	**4.80%**

A: Length of Insurance records of the village

***** Premium rate increase is limited to 20% and premium rate decrease is limited to (-10%) of the current premium rate