Agrekon

VOL. 13 No. 4 OCTOBER 1974

REQUIREMENTS FOR CONTRIBUTIONS

Articles in the field of agricultural economics, suitable for publication in the journal, will be welcomed.

Articles should have a maximum length of 10 folio pages (including tables, graphs, etc.) typed in double spacing. Contributions, in the language preferred by the writer, should be submitted in triplicate to the Editor, c/o Department of Agricultural Economics and Marketing, Pretoria, and should reach him at least one month prior to date of publication.

The journal is obtainable from the distributors: "AGREKON", Private Bag X144, Pretoria.

The price is 25 cents per copy or R1 per annum, post free.

The dates of publication are January, April, July and October.

"AGREKON" is also published in Afrikaans.

Contents

DETERMINATION OF DIFFERENTIATED COVER AND PREMIUM RATES FOR COMPREHENSIVE CROP INSURANCE FOR MAIZE

by

A. DE VILLIERS
Division of Agricultural Production Economics

I. INTRODUCTION

Differentiated cover and premium rates for various production regions are an essential prerequisite for crop insurance, on the one hand to offer a fair deal to the insured parties by making premium costs a factor of the specific risk situations, and on the other hand to protect the insurer against the acceptance of too high insurance risks.

II. METHOD OF CALCULATION

Differentiated premium rates for comprehensive crop insurance for maize can be calculated for various districts by applying the premium formula which is used by the Federal Crop Insurance Corporation in the United States of America.[1]) The formula is based on the principle that annual yields are normally distributed around long-term average yields. It can therefore be predicted that annual yields will vary within certain limits around the long-term average yields.

The formula is derived as follows:

LY = long-term average yield level for production region

Y = yield level for specific district in region for specific year

D = level of cover

N = area of the crop which is insured

n = area of the crop where the yield level (Y) is lower than the level of cover (D)

$A = \frac{n}{N}$

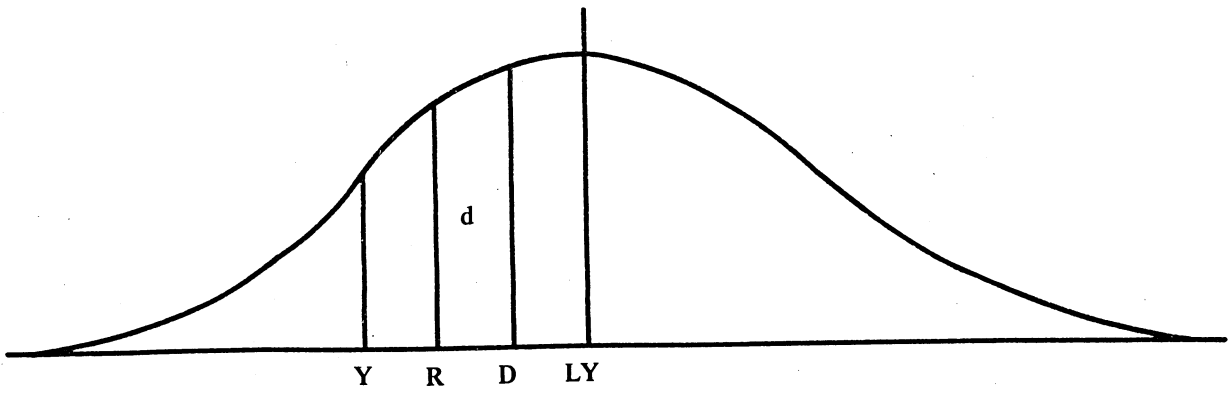
R = average yield level in the portion (n) with yield level (Y) lower than level of cover (D)

s = standard deviation of Y around LY

d = altitude of ordinate at D

$sm = \frac{D-Y}{s}$

P = calculated premium



1. Botts, R.R. and Boles, J.N. Use of normal-curve theory in crop insurance ratemaking, Journal of Farm Economics, Wisconsin, U.S.A., Vol. 40, No. 3, August 1958

Claims payable in a specific year = $\sum (D - Y)$

$$\text{therefore } P = \frac{1}{n} (nD - \sum Y)$$

$$\text{but } R = \frac{1}{n} \sum Y$$

$$\text{therefore } \sum Y = nR$$

$$\text{and } nD - \sum Y = nD - nR$$

$$\text{therefore } P = \frac{n (D - R)}{N}$$

$$= A (D - R)$$

It can further be shown that the value R of a truncated normal distribution = $Y - \frac{dsm}{A}$ [2]

Therefore $P = AD - AY + dsm$

$$= \frac{n}{N} (D - Y) + dsm$$

Three assumptions are used in the application of the formula in respect of maize and wheat in the United States of America:[3]

(i) D = 0,60 LY, i.e. the cover is 60 per cent of the long-term average yield level;

(ii) s = 0,25 LY, i.e. the standard deviation of Y around LY is equal to 25 per cent of the long-term average yield level; and

(iii) a minimum premium of 0,011/5 LY applies, i.e. if there are no claims a minimum premium of 1,15 per cent of the long-term average yield level is taken as the culculated premium.

The following are the two chief factors which determine the size of the premium:

(i) $\frac{n}{N}$; a relatively high ratio means that claims were relatively heavy and a relatively high premium will therefore be necessary; and

(ii) D — Y; the size of the difference if Y is lower than D determines the extent of the loss which must be made good and therefore the premium necessary to recover the claim.

The premium for a specific season is the arithmetical average of a number of representative years. Since the administrative costs of the Federal Crop Insurance Corporation's crop insurance scheme are guaranteed by the state, the premiums need only be sufficient to recover claims in the long-term.

III CALCULATION OF DIFFERENTIATED COVER AND PREMIUM RATES FOR COMPREHENSIVE CROP INSURANCE FOR MAIZE IN THE HIGHVELD REGION

The premium formula was applied to the comprehensive crop insurance data of an insurance co-operative, but no meaningful results were obtained because the data were too limited in extent and frequency. Other sources were then used, namely the average maize yield per district as determined in the final revised maize crop estimates.[4] The calculations were made only for the districts in agro-economic region B, because analyses showed that the degree of risk in maize production in the other agro-economic regions in the Highveld Region is too high to justify insurance.[5] The following additional assumptions were used, namely:

(i) The five-year sliding average yield levels of maize in agro-economic regions B1, B4 and B5, with an adjustment for upward trends, was accepted as the long-term average yield level (LY). In the cases of agro-economic regions B2, B3 and B6, for which no long-term average maize yields on an agro-economic regional basis were available, the data for B5 were taken as being applicable.

(ii) The level of cover was taken as D = 0,60 LY for all districts. Analyses showed that a 60% level of cover is sufficient to cover pre-harvest production costs, and therefore meets the requirements of crop insurance.[6] An additional cover of D = 0,75 LY was also calculated for the districts in Agro-economic region B1. Because of the considerably lower degree of risk in maize production in this region producers will probably only be interested in crop insurance if a higher level of cover is offered which also provides protection against possible loss of profits.

(iii) The average yield levels per district were taken as the actual yield levels (Y) per district. Where Y was lower than D for a specific year, it was assumed that there would be a claim and the necessary premium was calculated. Where Y was greater than or equal to D for a specific year, it was as-

2. Ray, P.K. Agricultural insurance, Pergamon Press, Oxford, 1967, p. 249.
3. Ray, P.K., *op. cit.*, pp. 251 — 252.
4. Division of Agricultural Marketing Research.
5. De Villiers, A. Ekonomiese aspekte van oesversekering. M.Sc. (Agric) thesis, University of Pretoria, 1974, Chapter VIII.
6. *Ibid.*

sumed that there would be no claim and a minimum premium of 1,15 per cent was made applicable.

(iv) In districts where Y was lower than D in more than five out of the ten years, maize crops were classified as uninsurable because the probability of losses is then greater than 0,5. The following districts were classified as uninsurable: Heilbron, Senekal, Bloemhof, Christiana, Ventersdorp and Ladybrand. It is of cause possible that the yields of individual farms may differ from the average results for the district and may therefore in fact be insurable.

(v) The calculated number of deviations from the average yield results per district below the appropriate line of regression were taken as the ratio $\frac{n}{N}$

(vi) The calculated coefficient of variation (KV) of the appropriate line of regression was taken as the standard deviation (s) of Y around LY, i.e. s = KV (LY).

For the purposes of this article only the basic premium, i.e. the premium which is sufficient to recover claims, is shown. Additional administrative costs are not taken into account here. The calculated results are as follows:

Calculated differentiated premium rates per district for comprehensive crop insurance for maize, 1962/63 to 1971/72

Agro-economic region and district	Number of years out of 10 years in which claims were made	Calculated basic premium 1962/63 to 1971/72
		%
I. At a 60 per cent level of cover		
B1. Transvaal Highveld		
Bethal	1	3,30
Delmas	0	1,15
Heidelberg	0	1,15
Nigel	0	1,15
Frankfort	2	8,53
Ermelo	1	4,50
Middelburg	0	1,15
Standerton	3	11,15
Witbank	0	1,15
Average per region		3,69
B2 and B3. Northern and Central Free State		
Koppies	4	19,08
Parys	2	7,38
Vredefort	4	12,70
Lindley	4	13,28
Marquard	2	9,37
Reitz	3	10,60
Average per region		12,06
B4. Western Transvaal		
Delareyville	2	6,60
Klerksdorp	0	1,15
Lichtenburg	1	2,65
Potchefstroom	1	8,49
Schweizer-Reneke	4	13,90
Wolmaransstad	5	21,05
Average per region		8,97

Table continued/ . . . . .

Agro-economic region and district/continued	Number of years out of 10 years in which claims were made	Calculated basic premium 1962/63 to 1971/72
		%
B5. North-Western Free State		
Bothaville	0	1,15
Bultfontein	4	15,88
Hoopstad	5	16,51
Kroonstad	3	11,88
Theunissen	5	18,87
Ventersburg	0	1,15
Viljoenskroon	0	1,15
Wesselsbron	1	5,07
Average per region		8,95
B6. Eastern Free State		
Bethlehem	1	3,45
Clocolan	1	3,93
Ficksburg	1	3,93
Fouriesburg	5	16,05
Average per region		6,84
II. At a 75 per cent level of cover		
B1. Transvaal Highveld		
Bethal	1	3,53
Delmas	1	2,56
Heidelberg	2	6,09
Nigel	2	4,12
Frankfort	5	15,68
Ermelo	4	9,77
Middelburg	3	5,70
Witbank	3	8,22
Average per region		6,95

IV CONCLUSION

Yields are the combined results of all physical, biological and management factors, and differentiated premiums based on average yields are therefore an indication of the actual risk situations. If the calculated differentiated premium rates are used as a guide, they can lead to greater interest in crop insurance by producers in the insured regions, without obliging the insurer to provide crop insurance cover in the high risk regions, and so achieve the goal of risk distribution.