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MALLEE WHEAT FARMERS' DEMAND FOR CROP AND RAINFALL INSURANCE

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Producers' demand for a crop insurance program with indemnities based on their actual yields and a rainfall insurance program with indemnities based on area rainfall is analysed. Actuarial costs of these hypothetical programs are estimated. Tobit procedures are used to analyse factors influencing the amount which farmers would be willing to pay for the alternative insurance programs. Factors related to the absolute size of risk and capacity to bear risk, as well as personal characteristics and risk attitudes of producers, have effects on the demand for insurance as hypothesised. Problems of adverse selection are associated with the area yield-based program, while both crop and rainfall insurance programs may involve some moral hazard. Producer participation in either program would be limited.

Rural income fluctuations and government programs of assistance have been a central theme of agricultural policy in Australia. Pooling arrangements through marketing boards and stabilisation schemes have reduced the price variability faced by many producers. However, much of Australia's farm output is subject to great climatic uncertainty, especially drought. Major droughts have resulted in a variety of responses by state and federal governments. Freebairn (1983) argues that many of these government responses have been deficient in meeting the goals of efficiency, equity and welfare support. Furthermore, the *ad hoc* nature of government responses to drought introduces another source of variability into agriculture.

Crop and rainfall insurance programs have been suggested by various groups as possible forms of drought assistance (IAC 1978; Lloyd and Mauldon 1986) and have been the subject of a recent Industries Assistance Commission inquiry (IAC 1985). Although crop insurance theoretically offers possibilities of spreading risk (Ahsan, Ali and Kurian 1982), Bardsley, Abey and Davenport (1984) concluded that insurance would not make a major contribution to risk management in the Australian wheat industry. The recommendation of the IAC inquiry (IAC 1986) that no government assistance be given to crop and rainfall insurance was based on the difficulty of estimating the level of producer participation, among other factors.

This paper explores the demand for crop and rainfall insurance programs by Mallee wheat producers. The general design of the hypothetical crop and rainfall insurance programs and estimates of actuarial costs are discussed in the first section. In the second section a theoretical model of factors affecting the decision to participate in these insurance programs and the maximum premium which producers would be willing to pay is developed. This is followed by a brief discussion of Tobit analysis (Tobin 1958; McDonald and Moffitt 1980), the estimation procedure used because

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the dependent variable has a number of zero level observations. The results derived from the Tobit analysis are presented in the fourth section. Some observations and recommendations for crop and rainfall insurance conclude the paper.

Crop and Rainfall Insurance

Two hypothetical, but possible, types of insurance programs were developed for consideration by wheat producers in the Mallee. The first, multiple peril crop insurance, was designed much like the US crop insurance program (Gardner and Kramer 1986; Patrick 1985). Unavoidable physical losses in wheat production would be insured. Indemnities paid would equal the shortfall between the coverage level and yields actually obtained by an individual producer. The second type of insurance was based on rainfall – precipitation occurring at a specified recording site in the general area – rather than the individual farmers' yields. The indemnity, if any, would be based on the amount of precipitation occurring during the insurance period according to a previously established schedule. Although not providing multiple peril coverage, rainfall insurance could avoid the problem of adverse selection and some of the moral hazard problems associated with crop insurance (Gardner and Kramer 1986; BAE 1986). With an accurate and fraud-proof method of recording rainfall instead of individual farm yield coverage, the administrative costs of the program could also be quite low (Lloyd and Mauldon 1986; Bardsley et al. 1984).

Multiple peril crop insurance

Estimated premium costs and coverage levels of the multiple peril crop insurance were based on data from the Mallee Research Station at Walpeup, Victoria. Trials using typical farming practices with respect to rotation, fallow, fertiliser and varieties had been conducted over the period from 1958-59 to 1977-78. The mean wheat yield obtained was 1.57 t/ha with a coefficient of variation of 41 per cent and there was no significant trend in yields (Kent 1982). Experiments conducted since 1977-78 had not used typical farm practices and average yields were substantially higher, but the coefficient of variation was very similar. This level of yield variability is quite typical of south-eastern Australia.[1]

Agronomists and farmers indicated that there had been no meaningful trend in Mallee farmers' yields since the 1950s. Furthermore, they argued that there is very little difference in wheat yields, in the typical rotation for a given soil type, due to management practices. This suggested that a crop insurance program with coverage levels based on average regional yields could be feasible in the Mallee. Such a program would have considerably lower administrative costs than one based on individual farmers' yield histories (BAE 1986).

The pure insurance or actuarial costs were estimated for two levels of

[1] Data provided by E. Wijnen and T. Ole (personal communication) on wheat yields from 47 New South Wales shires for the period 1945-46 to 1980-81 indicate an average coefficient of yield variability of 40.5 per cent. About one-half of the shires have coefficients of variability of wheat yields between 36 per cent and 44 per cent.

coverage assuming normal and beta distributions of yields.[2] For a mean yield of 1.6 t/ha, the 50 per cent and 75 per cent insurance coverage levels correspond to yields of 0.8 t/ha and 1.2 t/ha, respectively. Assuming yields are normally distributed gives pure premium costs of 3.97 per cent of mean yields ($7.49/ha with wheat at $120/t) for the 50 per cent coverage level and 6.88 per cent ($12.96/ha) at the 75 per cent coverage level.[3] If a beta distribution of yields is assumed, then the estimated pure insurance costs are 2.62 per cent of mean yields ($4.94/ha) for the 50 per cent coverage level which is lower than with the normal distribution. However, premium costs are higher, 8.15 per cent of mean yields ($15.35/ha), with the beta distribution for the 75 per cent coverage level.[4]

Insurance premiums would be higher than actuarial costs because of the costs of risk bearing, operating costs and administrative expenses. The cumulative loss ratio (claims paid relative to premiums received over time) for hail and fire insurance on Australian crops has been about 0.7 (Lloyd and Mauldon 1986). Assuming a cumulative loss ratio of 0.667 and the higher levels of pure insurance costs, results in premium rates of about 6.0 per cent and 12.3 per cent of 1.6 t/ha average production for the 50 per cent and 75 per cent levels of coverage. With wheat at $120/t, premiums would be $11.50/ha and $23.60/ha for the 50 per cent and 75 per cent coverage levels, respectively.

The indemnity would be calculated on the difference between the coverage level and actual yield. For example, if a farmer harvested 0.6 t/ha, the indemnity would be 0.2 t or $24.00 with 50 per cent coverage and 0.6 t or $72.00 with the 75 per cent coverage level.

Area rainfall insurance

Area rainfall insurance would provide only partial protection for losses caused by factors beyond a producer's control because losses other than those associated with inadequate rainfall would not be covered by insurance. Effectiveness would also depend on the extent to which rainfall on an individual farm corresponds with rainfall at the recording site. Furthermore, although total rainfall is the major factor in determining wheat yields, the timing of precipitation, initial soil moisture, temperature, soil type and wheat variety also influence the relationship between rainfall and yield (Greacen and Hignett 1976; French and Schultz 1984).

For the Mallee, rainfall in the April 1 to October 30 period is critical for wheat production. Rainfall before April 1 may contribute to soil moisture, but has less impact on production than later precipitation. Rain

[2] Although the hypothesis that yields were not normally distributed could not be rejected by the Kolmagorov-Smirnov or Shapiro-Wilk tests, the mode was significantly larger than the mean and the distribution was skewed to the left, −0.28.

[3] Botts and Boles (1958) illustrate, using the area under the normal curve, how the pure insurance cost of a specific percentage coverage level can be determined from the mean yield and standard deviation.

[4] The Farm Income Protection Task Force (1983) provides a series of tables indicating percentage premium rates for beta distributions which have different assumptions about the maximum yield and coefficient of variation. Table C.4 with a maximum yield of 180 per cent of the mean and coefficient of variation of 42.5 per cent was used. Actual values for the Mallee Research Station were a yield maximum of 178 per cent and a coefficient of variation of 41 per cent.

received after October 30 contributes very little to yield and may reduce mature grain quality. French and Schultz (1984) report threshold water use for wheat of 110 mm, with a potential yield of 20 kg/ha with each additional millimetre of water use. If less than 100 mm of precipitation were received during the April 1 to October 30 period, it is unlikely that any wheat would be produced. Assuming reasonable distributions of rainfall, yields 50 per cent or more and 75 per cent or more of average would probably be obtained with 175 mm and 200 mm of precipitation, respectively. The probabilities of these amounts of rainfall are indicated in Table 1.

In Table 1 the insurance indemnities which would be paid to insured farmers for specified precipitation levels are presented. It is assumed that precipitation in excess of 150 mm would have a larger effect on production (smaller indemnities) than previous rainfall. Coverage 1 provides insurance indemnities similar to those which would be received with the 75 per cent level of crop insurance, while coverage 2 is similar to the 50 per cent level with wheat at $120/t. Discussions with researchers and farmers in the area indicated that although crude, the relationship was probably rather accurate.[5]

Theoretical Model

A farmer's decision to purchase crop or area rainfall insurance, as well as the maximum insurance premium a producer would be willing to pay, can be considered in the framework of expected utility theory. Producers

TABLE 1

Probability of Receiving Specified Amounts of Precipitation, Rainfall Insurance Indemnities and Estimated Premium Costs per Hectare for Mallee Wheat

Recorded precipitation: April 1 to October 30 Amount	Probability (%)[a]	Coverage 1 (75% coverage) $	Coverage 2 (50% coverage) $
Less than 100 mm	2.8	148.20	98.80
100–125 mm	5.6	111.15	67.93
125–150 mm	6.5	74.10	37.05
150–175 mm	11.2	49.20	12.35
175–200 mm	12.2	24.70	–
200 mm or more	61.7	–	–
Estimated premium cost[b]		17.30	8.65

[a] These probabilities were derived from Hopetoun monthly rainfall data for 107 years during the 1875 to 1986 period (*Hopetoun Courier* 1987).
[b] Premium costs were estimated as the actuarial costs for the 50 per cent and 75 per cent crop insurance coverage levels plus an insurance cost factor of about 10 per cent of actuarial costs.

[5] Based on the historical rainfall probabilities in Table 1, the expected values of the insurance indemnities would exceed the estimated premium costs by 34 per cent for coverage 1 and 20 per cent for coverage 2. This indicates that some modifications of premiums and/or indemnities would be necessary before implementing a rainfall insurance program.

seek to maximise expected utility and may use a variety of responses or actions in their risk management strategies. However, risk responses will be implemented only up to a point, the point at which the expected benefits from further reductions in risk would be less than the costs or decreases in income associated with the additional risk management measures.

Crop and rainfall insurance programs are means by which risks are shifted from a producer to the insurer. Multiple peril crop insurance, as discussed previously, would shift the risk of an individual's yields being below the historical regional average yields because of unavoidable causes. Area rainfall insurance, in contrast, shifts only the risk of precipitation being less than the specified amounts at the recording site. The premiums represent the costs associated with shifting the risks insured. Individuals would include insurance in their risk management strategies if the insurance premium were less than the cost of other risk responses having the same effect. For example, insurance provides liquidity in the case of losses due to insured causes, and liquidity may also be provided by maintaining financial reserves. Alternatively, insurance may fill a void in a risk management strategy and reduce risk to a more acceptable level. For example, crop insurance may complement the reduction in production risk associated with enterprise diversification and fallowing before planting.

The demand for crop and rainfall insurance is hypothesised to be influenced by several factors. Farmers differ in their risk attitudes, but most Australian producers appear to be risk averse (Bond and Wonder 1980). Farmers who are more risk averse with respect to losses, or producers who indicate that they have become more conservative in attitude over time, would be more likely to participate in crop and rainfall insurance programs and would be willing to pay higher premiums. Similar effects would be hypothesised for the area planted to wheat because of the absolute size of the possible loss. Farmers with larger amounts of debt would be expected to participate in insurance programs and be willing to pay higher premiums. The reverse situation would be hypothesised for farmers with larger net worths. Age and education may also influence farmer participation in insurance programs, but the direction of the effect of these variables is difficult to predict.

Coverage levels under the crop insurance program are to be based on average regional yields and indemnities on actual individual yields. If there were differences in yields among farmers, farmers with above average expected yields would be less likely to participate. This could lead to severe problems of adverse selection in the crop insurance program. Greater variability in expected wheat yields and reliance on the wheat enterprise would also lead to greater participation in crop insurance. In contrast, area rainfall insurance indemnities are not related to experiences of producers. Because there is no link between an individual farmer's expected yields or yield variability and possible rainfall insurance indemnities, these variables are not included in the area rainfall insurance model.

Land is commonly fallowed before planting wheat to accumulate soil moisture which may partially substitute for rainfall after planting. Farmers who fallow more of their land are expected to be less likely to participate in rainfall insurance and to be unwilling to pay higher premiums. Some farmers in the Mallee grow legume crops such as dry peas and lupins, which are generally considered risky, to intensify their cropping operations. These legume producers would be more likely to participate in the insurance programs because legume production is generally undertaken by producers who are under economic pressure—those who may be more likely to purchase insurance.

Econometric Model

When farmers were asked to indicate the maximum premium that they would be willing to pay for the different types and coverage levels of insurance, a number of farmers indicated that they would not pay to participate in the insurance programs. The dependent variable in the analysis, the maximum premium, is therefore clustered at zero for a number of observations. To avoid bias in the coefficients of this truncated model which would result from estimation by ordinary least squares, the maximum likelihood Tobit technique is used (Tobin 1958; McDonald and Moffitt 1980; Ziemer and White 1981).

Following McDonald and Moffitt (1980), the underlying relationship is:

$$(1)\qquad \begin{aligned} y_t &= X_t\,\beta + u_t \text{ if } X_t\,\beta + u_t \geq 0 \\ &= 0 \qquad\quad \text{if } X_t\,\beta + u_t \leq 0, \\ &\text{for } t = 1, 2, \ldots, n, \end{aligned}$$

where n is the number of observations, y_t is the dependent variable, X_t is a vector of independent variables discussed in the previous section, β is a vector of parameters and u_t is a normally distributed error term with mean zero and variance σ^2.

Tobin (1958) has shown that the expected value of y is

$$(2)\qquad E(y) = X\,\beta\,F(z) + \sigma\,f(z)$$

where z equals $X\,\beta/\sigma$ and $F(z)$ and $f(z)$ are the cumulative distribution and density functions, respectively, of a normal variable. The expected value for observations above zero, y^*, is $X\,\beta$ plus the expected value of the truncated error term which has been expressed by Amemiya (1973) as:

$$(3)\qquad E(y^*) = X\beta + \sigma\,f(z)/F(z).$$

The relationship between the expected value of all the observations, $E(y)$, the expected value of observations above the limit, E(y*), and the probability of being above the limit, $F(z)$, is

$$(4)\qquad E(y) = F(z)\,E(y^*).$$

McDonald and Moffitt (1980) decompose the effect of a change in the X_i variable on y into two parts as:

$$(5)\qquad \partial E(y)/\partial X_i = F(z)\,(\partial E(y^*)\,/\partial X_i) + E(y^*)\,(\partial\,F\,(z)/\partial\,X_i).$$

Thus, the total change consists of the change in y for observations above the limit, weighted by $F(z)$ and the second part is the change in the probability of being above the limit, weighted by $E(y^*)$. They also show that the fraction of the total effect due to response above the limit can be obtained by calculating

$$(6) \qquad 1 - zf(z)/F(z) - f(z)^2/F(z)^2.$$

This fraction can be used to adjust the βs to obtain the effect for observations above the limit.

Tobin (1958) and Amemiya (1973) have shown that consistent estimates of β and σ, used in the decomposition procedure, can be obtained with maximum likelihood estimation techniques. The Tobit analysis thus incorporates information about the potentially participating producers as well as those who would not participate.

Results

Interviews were conducted with 60 randomly selected Mallee wheat producers, about 20 per cent of the producers in Karkarooc shire.[6] Information regarding the crop and rainfall insurance programs had been sent to producers a few days before the interview. This material provided some background to mechanics of the programs and schedule of indemnities, but no specific cost information. Enumerators reviewed the programs with farmers and answered general questions about the hypothetical programs to clarify understanding. Farmers were asked the maximum premiums that they would be willing to pay for 50 per cent and 75 per cent coverage levels of crop insurance and the two levels of area rainfall insurance. Producers were also asked to select among alternative levels of coverage and premiums.[7]

Of the 60 farmers interviewed, 25 per cent indicated that they would not participate in the crop insurance program with the 75 per cent level of coverage. For those willing to participate in the crop insurance program, maximum premiums ranged from \$2.22/ha to \$29.64/ha with an average of \$16.19. One-half of the producers would be willing to pay approximately the estimated actuarial cost of the coverage or more, but only 20 per cent would pay the estimated premium cost of crop insurance. Almost 32 per cent of the farmers would not participate in crop insurance with the 50 per cent coverage level. Premiums for those who would participate averaged \$9.51/ha with a range of \$1.48/ha to \$14.82/ha.

Almost 57 per cent of the farmers would not participate in the area rainfall insurance program with coverage 1. The maximum premiums for those who said they would participate ranged from \$2.47/ha to \$37.05/ha with an average of \$15.57/ha. Less than 12 per cent of the producers would pay more than the estimated expected value of the rainfall insurance indemnities calculated later using historical rainfall probabilities. Participation would drop to about 38 per cent of producers with the lower level of rainfall insurance, coverage 2, and the average premium was \$10.31/ha.

Results of Tobit analyses for the higher levels of crop and area rainfall insurance are presented in Table 2. The signs of the estimated coefficients

[6] Of the farmers contacted, less than 6 per cent refused to co-operate in the study.

[7] For a more detailed discussion of survey procedures, farmers' risk perceptions, management responses used by farmers and analysis of the other coverage levels see Patrick, Lloyd and Cary (1985).

TABLE 2

Estimated Tobit Regression Coefficients and Standard Errors for Crop and Rainfall Insurance Premiums Which Mallee Wheat Producers Would be Willing to Pay

	75% Crop insurance		Rainfall insurance	
Variable	Estimated coefficient	Standard error	Estimated coefficient	Standard error
Intercept	42.253	13.765	52.044	20.749
Expected wheat yield (t/ha)	−27.628	7.922***		
Yield standard deviation (t/ha)	10.782	8.469		
Percentage of land in wheat	0.322	0.150**		
Percentage of land in fallow			− 0.763	0.307**
Area of wheat (ha)	0.007	0.008	0.030	0.015*
Age of operator (years)	− 0.140	0.101	− 0.187	0.177
Education of operator (years of schooling)	− 0.868	0.654	− 2.989	1.282**
Amount of debt ($1000)	0.057	0.021***	− 0.002	0.038
Net worth ($1000)	0.003	0.004	− 0.011	0.006*
Legume producers (0 = no, 1 = yes)	4.333	2.804	14.259	5.365***
Risk attitude toward losses[a]	4.270	2.725		
More conservative[b] (0 = no, 1 = yes)			9.040	4.640**

*, ** and *** indicate significance at levels of 10 per cent, 5 per cent and 1 per cent, respectively.

[a] Individuals who are risk preferring with respect to losses are coded as zero, and risk averse individuals (those preferring a certain small loss) are coded as one.

[b] Individuals were asked whether their attitude toward variability had changed. Those indicating they had become more conservative are coded as one and others as zero.

were generally consistent with theoretical model and, if not statistically significant, were generally larger than their standard errors. Preliminary analysis considered alternative specifications of the reliance on wheat and risk attitude variable. The percentage of land in wheat performed better than the percentage of gross receipts from wheat in the crop insurance equation. Becoming more conservative was statistically significant in the rainfall insurance equation, while the risk attitude toward losses performed better in the crop insurance equation. Percentage debt did not perform as well as net worth and amount of debt in either equation.[8]

The premiums which farmers would be willing to pay for crop insurance were influenced by characteristics of the wheat production, level of debt and risk attitudes of the producer. Expected wheat yield had a negative effect on the premium, suggesting that an area crop insurance program might encounter difficulties of adverse selection. All of the other coefficients related to wheat production were positive, indicating that as the variability of wheat yields, area in wheat and percentage of land in wheat increased, so would the premium paid for crop insurance. Coeffi-

[8] The largest simple correlation between independent variables in the models was 0.43 between net worth and area in wheat. The absolute values of the simple correlations between expected yield and net worth, expected yield and the standard deviation of yield and between age and education of the operator were the only ones which exceeded 0.3.

cients for age and years of schooling of the operator were negative and larger than their standard errors, indicating older farmers and those with more schooling would pay less for crop insurance. The amount of debt was highly significant and associated with higher crop insurance premiums. Although the negative sign on the net worth variable is consistent with expectations, the coefficient is smaller than its standard error. Farmers who are legume producers and those who are averse to risk would be willing to pay higher crop insurance premiums.[9]

Higher rainfall insurance premiums were associated with larger areas of wheat, production of legumes and becoming more conservative in attitude toward variability. Higher levels of net worth and greater percentages of land in fallow were associated with lower rainfall insurance premiums. Age and education of the operator both had negative coefficients and education was statistically significant. More schooling represents a larger investment in human capital and this greater wealth may be associated with lower risk aversion. The negative sign for the amount of debt was not expected, but the coefficient was much smaller than the standard error.[10]

TABLE 3

Estimated Elasticities for Crop and Area Rainfall Insurance Premiums for Mallee Wheat Producers

Variable	Crop insurance		Rainfall insurance	
	Total	Conditional	Total	Conditional
Expected wheat yield	−3.702*	−2.507*		
Yield standard deviation	0.622	0.421		
Per cent in wheat	0.768*	0.520*		
Per cent in fallow			−2.328*	−0.784*
Area of wheat	0.211	0.143	0.967*	0.326*
Age	−0.517	−0.350	−0.778	−0.262
Education	−0.717	−0.486	− 2.792*	−0.940*
Amount of debt	0.250*	0.169*	−0.007	−0.002
Net worth	0.200	0.135	−0.761*	−0.256*
Legume producer	0.114	0.077	0.425*	0.143*
Risk attitude	0.207	0.140		
More conservative			0.368*	0.124*

* Indicates that elasticities were calculated from coefficients which were significant at the 10 per cent level or higher.

[9] Discriminant analysis indicated a somewhat different set of variables contributed significantly to distinguishing between nonparticipant, low premium ($5/ha to $15/ha) and high premium ($17/ha or more) crop insurance groups. Expected wheat yields, yield variability, percentage of land in wheat, amount of debt, legume production and risk attitude were variables from the Tobit analysis which contributed to discriminating among groups. Age and education of the operator did not contribute significantly to discrimination among groups. An insurance use index and percentage of land in crops contributed to group discrimination, but were not included in the Tobit analysis (Patrick and Cary 1987).

[10] Percentage of land fallowed, whether legumes were produced and age and education of the operator as well as expected wheat yield contributed significantly discriminating between participants and non-participants in the area rainfall insurance. The area of wheat, net worth and whether the producer had become more conservative were statistically significant in the Tobit analysis, but did not contribute to group discrimination (Patrick and Cary 1987).

The Tobit coefficients in Table 2 cannot be directly interpreted as the effect on the insurance premium for a given change in an independent variable for participating farmers. The term $1 - zf(z)/F(z) - f(z)^2/F(z)^2$, in equation 6, represents the fraction of the mean total change in the crop or rainfall insurance premium due to individuals who would participate in the program. For crop insurance, this is 0.6774 compared with 0.3369 for area rainfall insurance. This implies that 67.7 per cent of the mean change in the crop insurance premium paid, given a change in the independent variables, would be attributable to individuals who would be participating in the program. For rainfall insurance, the lower value of 33.7 per cent implies that more of the change in premium, 66.3 per cent, would be attributable to changes in the probability of producers' participation. Based on the Tobit regression equations with the independent variables at their mean values, the predicted probability of a crop insurance premium greater than zero (participation in the program) was 87.7 per cent compared with the observed 74.1 per cent. In contrast, the predicted probability of participation in rainfall insurance was the same as the observed probability of participation, 44.8 per cent.

The elasticities for crop and area rainfall insurance premiums derived from the estimated Tobit regression equations, at the means of the independent variables, are presented in Table 3. The total elasticities indicate the percentage change in the insurance premium which will occur from a 1 per cent change in an independent variable. The conditional elasticities represent the change in the insurance premium occurring from responses of participating producers. The difference between the total and conditional elasticities results from changes in the participation in the insurance programs (Huang, Fletcher and Raunikar 1981). For example, given a 1 per cent increase in expected wheat yields, the crop insurance premium would decrease by 3.702 per cent. Of this total change, −2.507 per cent would result from changes by participating producers and the remainder, −1.195 per cent, from changes in producer participation.

Expected wheat yield had by far the largest elasticity (−3.702) of the variables considered for crop insurance. The standard deviation of wheat yields and percentage of land in wheat had total elasticities which exceeded 0.6, while the elasticities for age and education of the operator exceeded −0.5. The amount of debt, although highly significant in the Tobit regression equation, had a relatively small elasticity, 0.250.

For area rainfall insurance, two variables had total elasticities with absolute values exceeding unity. A 1 per cent increase in the educational level of producers would result in a decrease in the area rainfall insurance premium of about 2.8 per cent overall and 0.9 per cent for participants. Elasticities of similar magnitude were associated with the percentage of land in fallow. An increase of 1 per cent in the area of wheat would result in almost a 1.0 per cent increase in premium, while a 1 per cent increase in age of the operator or net worth would lead to a 0.8 per cent decrease in the premium.

Conclusions

In this study the factors influencing Mallee wheat farmers' demand for crop and area rainfall insurance were analysed. Tobit regression analysis was used to estimate responses utilising information from the participants and non-participants in the hypothetical programs. The elasticities, derived from the estimated relationships, were decomposed into the part attributed to changes by participants and the part attributed to changes in program participation by producers. Changes in participation had relatively greater impact on the area rainfall insurance program than on the crop insurance program.

Not all of the producers would participate in the hypothetical insurance programs. This lack of participation is consistent with the use of alternative strategies of risk management by producers. Furthermore, non-participation would be higher (almost 57 per cent) for the area rainfall insurance program than for the multiple peril crop insurance program (25 per cent) which had indemnities related to actual yields of individual producers. Many producers expressed concern about tampering with rainfall measurement. Even when assured area rainfall measurement would be tamper-proof, producers indicated a strong preference for an insurance program based on their actual yields.

Results from the Tobit analyses indicate that producer behaviour is generally consistent with hypotheses derived from the maximisation of expected utility. Factors related to the absolute size of risk and capacity to bear risk, as well as personal characteristics and risk attitudes of producers, had effects on the demand for insurance as hypothesised.

The low level of potential participation in crop and rainfall insurance by Mallee farmers is consistent with the low observed levels of participation in voluntary programs in other countries. Gardner and Kramer (1986) estimate an actuarially sound program would induce participation of 10–20 per cent of producers and a subsidy of more than 50 per cent of the premium would be necessary to enroll the majority of farmers. In South Africa, with a 25 per cent premium subsidy, only about 25 per cent of wheat growers and 15 per cent of maize producers participated (BAE 1986). Furthermore, the factors influencing the premium that farmers would be willing to pay are similar to factors influencing the proportion of crops insured at more aggregate levels of analysis, for example Nieuwoudt, Johnson, Womack and Bullock (1985), Gardner and Kramer (1986).

The crop insurance program was developed with coverage based on the average yield for the area. This was based on the assumption that yield differences among farmers were negligible. Expected wheat yield was highly significant and had a large negative elasticity associated with it. This suggests that differences do exist in the area and that these differences are well-recognised by producers. Implementation of programs based on average area yield coverage, even in an apparently homogeneous area such as the Mallee, is likely to have serious problems of adverse selection of participants. Adverse selection would lead to higher than expected loss ratios and an increase in premium rates or other changes in the program.

Although not addressed directly by the study, some possible moral hazard difficulties are also suggested by the results. The demand for crop insurance was affected by the percentage of land in wheat. Lower percentages of land in fallow lead to greater participation in area rainfall insurance programs. Availability of crop or rainfall insurance programs might cause farmers to shift production practices and to modify their risk management strategies. Unsubsidised insurance programs may provide for efficient gains in risk management. However, with subsidised insurance, care must be exercised to avoid incentives for production practices leading to greater vulnerability to climatic variation, and possibly to environmental degradation.

Participation in the crop and area rainfall insurance programs would be limited. One quarter of the producers would not participate in the crop insurance program and over one-half would not participate in the rainfall insurance program. Twenty per cent or less of the producers would be willing to pay the estimated full costs of the insurance programs. This suggests very limited potential for commercial establishment of programs under current circumstances of drought assistance. However, if governments modified their responses to a drought, this would lead farmers to change their risk management strategies and could have substantial impacts on the demand for insurance.

APPENDIX

Means and Standard Deviations of Dependent and Independent Variables with Relative Frequency of Binary Variables

Variable	Mean	Standard deviation
Crop insurance premium ($/ha)	11.878	9.044
Rainfall insurance premium ($/ha)	6.981	9.730
Expected wheat yield (t/ha)	1.667	0.223
Yield standard deviation (t/ha)	0.718	0.176
Percentage of land in wheat	29.614	10.990
Percentage of land in fallow	33.552	9.523
Area of wheat (ha)	356.172	183.164
Age of operator (years)	45.828	14.338
Education of operator (years)	10.276	2.033
Amount of debt ($1000)	54.052	65.727
Net worth ($1000)	759.914	446.009
Legume producers	32.75 per cent produced legumes	
Risk attitude toward loss	60.34 per cent were risk averse	
More conservative	44.83 per cent had become more conservative	

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