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CROP INSURANCE AS A STRATEGY FOR AGRICULTURAL DEVELOPMENT

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An essential feature of agricultural development is the modernization of traditional agriculture. The achievement of greater productivity in agriculture requires greater use of capital inputs such as fertilizer, and adoption of new production techniques. Crop insurance is a policy option which can be used to reduce yield risk and thus encourage greater use of purchased inputs. It has been argued that reducing the adverse effects of crop losses can benefit communities as well as individual farmers:

[A]n international crop insurance system would help protect agricultural investments and encourage production in areas where people are underfed...It could be a major contribution to help to promote the economic growth of the developing world. (Oury)

One factor hindering expansion of crop insurance in developing countries is doubts about its feasibility. The objectives of this paper are to review the operation and performance of existing crop insurance programmes in selected developed and developing countries, and to present a procedure for evaluating the attractiveness to farmers of such programmes. The second objective will be accomplished by demonstrating the ease with which some recent developments in decision theory can be applied to micro level policy analysis. By constructing a normative risk model with modest data requirements, policy analysts can evaluate the effects of changes in programme parameters on the incentives to purchase crop insurance.

A Review of Crop Insurance Schemes

Crop insurance programmes are currently operating in at least 26 countries.² It is not possible in the space available to review all of these programmes; however, four programmes will be examined to determine what lessons might be drawn from them. Two long running programmes in developed countries will be described first. One programme, in Japan, operates on a compulsory basis. The other, in the United States, operates on a voluntary basis. Two quite different programmes in developing countries will be examined next. The Sri Lankan programme has operated on a compulsory, nationwide basis for many years. A very new Bolivian programme is of interest because it differs from the other programmes discussed, and it is specifically designed to encourage the adoption of new technology.

Japan

In 1880, Paul Mayet, a German adviser to the Japanese government, proposed a set of agriculturally oriented institutions to provide relief for farmers (Mayet). One of these institutions was a crop insurance programme to compensate farmers for crop losses from natural causes. Nearly 40 years later, the Livestock Insurance Law of 1929 was passed, followed by the Agricultural Insurance Law of 1939. The Agricultural Loss Compensation Law of 1947 revised and merged the two programmes.

The Japanese programme operates with a decentralized administrative structure (Kada). Farmers belong to village level mutual relief associations. The associations belong to regional federations to which they pay premiums for coinsurance or reinsurance. The federations pay premiums to the national government which pays insurance benefits and subsidies to the federations. The government also provides loans to the federations when reserves are inadequate

for covering large losses. The Japanese programme has operated successfully for many years during which time some changes have been made in programme operation. Two key features have remained constant: the programme operates on a compulsory basis, and the government has provided large subsidies for operating expenses and in some cases for underwriting losses.

United States

Multiple crop disaster insurance was first offered in the United States by private companies. The efforts were unsuccessful, largely because of coverage of price as well as yield risk, insufficient geographic dispersion of risk, and inadequate data for premium calculation. After these unsuccessful private attempts, the Federal Crop Insurance Act of 1938 established the Federal Crop Insurance Corporation to administer a voluntary programme for wheat.

The U.S. crop insurance programme, which began in 1939 as a nationwide programme, encountered large underwriting losses during the early years of operation, primarily because of adverse selection (Kramer). The loss ratio (indemnities divided by premiums) exceeded 1.5 in each of the first 3 years of operation. In addition to the expected subsidies for administrative expenses, large subsidies were required for underwriting losses. Because of low levels of participation and large underwriting losses, the programme was reduced to an experimental basis in 1947. Since that time it has gradually expanded and generally operated on a satisfactory basis. An exception was during an expansion phase of the programme in the 1960s when premiums got out of line with indemnities and protection levels. As recently as 1980 only 8 percent of U.S. acreage was insured. The Federal Crop Insurance Act of 1980 greatly extended the availability of crop insurance. The programme is being rapidly expanded to all major agricultural counties and to most commercial crops. To encourage participation, a large premium subsidy was added.

Sri Lanka

In 1958, the government of Sri Lanka began a crop insurance programme for rice as a means of increasing agricultural production. A pilot scheme operated on 28,000 acres. The Crop Insurance Act of 1961 allowed the gradual expansion of the programme. In 1973, legislation was passed which made the programme mandatory on an islandwide basis covering 1.4 million acres (APRACA).

Compulsory participation has not been enforced; as a result, participation has been only about 30 percent. The programme was designed with the assumption that all farmers would participate. The low level of actual participation has resulted in adverse selection. From 1975 to 1979 there were underwriting losses of R6.36 million. The programme is being revised by increasing premiums in high risk areas and reducing premiums for those farmers with a favourable loss history.

Bolivia

A programme has recently begun in Bolivia which offers crop credit insurance (Maurice). Under this programme, agricultural loans are insured against crop failures. The aim is to encourage farmers to obtain credit which will facilitate the adoption of new technology. While the programme is too new to evaluate, there appear to be some potential positive impacts on agricultural development.

The programme was started in the Cochabamba Valley. After meetings with 700 of the area's potato farmers, 50 signed up for the programme. The agents of the crop credit insurance agency, ASBA, helped the farmers obtain credit from the Bolivian Agricultural Bank. The ASBA agents promoted a three pronged, integrated programme involving insurance, credit, and extension.

Extension agents were brought in to explain the use of improved seeds, fertilizer, and other inputs. All of the insured farmers used the new technology for the first time.

The results were dramatic, with yields increased from a 5- to 8-ton range to a 16- to 41-ton range. All the insured farmers exceeded the 12-ton guarantee level, including one group which suffered a hail storm and frost. Their plants had to be destroyed, but because of the hardy nature of the new seed potatoes, the plants came back and all the insured farmers exceeded the guarantee with yields of at least 26 tons each. Recognizing the potential market effects of the substantial yield increases, the ASBA agents are now encouraging the construction of adobe silos for storage.

This anecdotal evidence suggests that crop insurance may have an influence on agricultural development in Bolivia, particularly when introduced as an integrated package with credit and extension programmes. However, it would be difficult to separate the effects of insurance from the effects of other programmes. As indicated, the introduction of this new institution may have impacts beyond the farm level, for example, in input and output markets and on the stability of regional income.

Models for Analyzing Crop Insurance Programmes

One approach to analyze farm level decisionmaking in regard to crop insurance is to use mathematical programming. A recent study by Hazell et al. used a mathematical risk programming model (MOTAD) to examine alternative types of crop insurance in Mexico and Panama. The purpose of this research was to identify the programme alternatives which would be most effective in reducing risk so as to encourage greater use of modern inputs or the adoption of high yielding varieties. The authors concluded that, in rainfed areas of Mexico, crop insurance combined with improved maize technology could increase maize output and raise average farm income. In Panama, where risk was of less importance, crop insurance would make only a marginal contribution to welfare, even when improved technologies were available.

While the Hazell et al. study provided useful information for policymakers, it relied on a complex, large scale programming model developed in previous studies. Most policy analysts in developing countries do not have access to such models and must rely on simpler approaches.

One promising normative approach to analyzing farm level policy impacts of crop insurance and other stabilization schemes is stochastic dominance analysis. This approach allows the comparison of various alternatives in a risk framework and has rather modest data requirements compared to mathematical programming. The simplicity does not come without cost, however, as one cannot use this approach to analyze diversification issues or regional impacts of policy changes. Stochastic dominance has previously been applied, for example, to the question of adoption of new technologies in developing countries (Anderson) and participation in price and income support programmes (Kramer and Pope).

A Model of the Crop Insurance Purchase Decision—Theory

The net returns for a farmer purchasing crop insurance can be represented by the following (the single crop case is considered for simplicity):

$$(1) \quad NR = [(P \cdot Y) - VC - PREM + INDEM] \cdot H,$$

where NR = net returns,
P = per unit price,
Y = yield per hectare,
VC = variable cost per hectare,
PREM = the insurance premium per hectare,
INDEM = per hectare indemnity for crop losses, and
H = number of hectares.

$$(2) \quad INDEM = [(G \cdot NY) - Y] \cdot PL,$$

where G = the yield guarantee level of the insurance,
NY = normal yield, and
PL = the price payment level used in calculating indemnities.

$$(3) \quad INDEM = 0 \text{ when } y > (G \cdot NY).$$

The difference in expected net returns with and without crop insurance is:

$$(4) \quad [-PREM + PL \cdot \int_0^{G \cdot NY} Y \, df(Y)] \cdot H,$$

where $f(Y)$ = the probability density function for yields.

Examination of expression (4) reveals that the incentives for purchasing crop insurance increase as the probability that yield falls below the guarantee level increases; that is, increases in yield risk raise the incentives to participate even for a risk neutral farmer. If the farmer is not risk neutral, then higher moments of probability distributions can be considered by examining the expected utility of the right side expression in equation (1).

Application

With historical prices and yields and estimated cost data, a probability distribution of net returns without crop insurance can easily be constructed for specific crops and regions. These data can be adjusted to construct a probability distribution of net returns with crop insurance by incorporating information on specific crop insurance schemes. Using stochastic dominance concepts (Meyer), the two distributions can be compared to determine if crop insurance would be preferred by all decisionmakers, all risk averters, or other more narrowly defined groups of decisionmakers. The effects of changes in programme parameters such as premiums (subsidies), guarantee levels, and price payment levels can be assessed by recalculating distributions and performing stochastic dominance rankings once again. Furthermore, differences in incentives for different farm sizes and technologies can be analyzed by calculating probability distributions for different costs of production, and once again performing the rankings.

Illustration

To illustrate the usefulness of stochastic dominance for investigating farm level incentives for purchasing crop insurance, an example is presented for Sri Lanka. As previously mentioned, the Sri Lankan programme is compulsory in theory, but compliance is lacking. In this example, some potential changes in the programme are examined. A representative farm in the Jaffna district was considered. Probability distributions of net returns with and without crop insurance were constructed using equation (1) and data from Gavan and Chandrasekera and the Ministry of Agriculture. Following the approach of Meyer, the distributions were compared for different classes of decisionmakers defined by upper and lower bounds on the absolute risk aversion coefficient. Risk aversion bounds used in the analysis are given in table 1. Groups 1 and 2 include risk preferring individuals; the other groups include individuals with progressively higher levels of risk aversion.

Table 1. Risk Aversion Coefficients

Utility group	Lower bound	Upper bound
1	-0.040	-0.020
2	-0.020	-0.000
3	0.000	0.002
4	0.002	0.005
5	0.005	0.010
6	0.010	0.030

A few illustrative results are presented in table 2 which compares the expected utility of net returns without crop insurance to the expected utility of net returns with crop insurance. A "1" indicates that the corresponding utility group would prefer not to purchase crop insurance, a "-1" indicates preference for insurance, and a "0" indicates that neither distribution dominates. The first row of the table compares no insurance with the existing programme. For the situation represented by the hypothetical farm, all utility groups would prefer no insurance. In subsequent rows, programme changes are simulated by raising the level of yield coverage (and the corresponding premium). Nonpurchase continues to be preferred until a 50 percent premium subsidy is added to the 80 percent guarantee.

Table 2. Stochastic Dominance Rankings

No insurance versus	Utility Group					
	1	2	3	4	5	6
50 percent coverage, no subsidy	1	1	1	1	1	1
70 percent coverage, no subsidy	1	1	1	1	1	1
80 percent coverage, no subsidy	1	1	1	1	1	1
80 percent coverage, 50 percent subsidy	1	1	0	-1	-1	-1

Conclusions

Crop insurance is one alternative that governments have at their disposal for reducing the risks faced by farmers. Several existing programmes have been examined, and it is clear that a variety of institutional arrangements have been developed. Institutional linkages with credit and extension programmes may in some cases be critical for crop insurance to have a positive effect on development. Further research on these institutional relationships is needed.

A model has been presented which can be used to consider, in a risk framework, farm level incentives for purchasing insurance. This type of model can be utilized to analyze the impacts of changes in crop insurance and related income stabilization programmes. Equity effects can also be evaluated by examining differences in purchase incentives for different farm sizes and tenure arrangements.

Notes

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²Those countries with multiple peril crop insurance programmes are: Bangladesh, Bolivia, Brazil, Canada, Chile, Costa Rica, Cyprus, Ecuador, France, India, Israel, Japan, Mauritius, Mexico, Panama, Philippines, Puerto Rico, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, United States, Venezuela, and Zimbabwe (Maurice).

References

- Anderson, J. R.**, "Risk Efficiency in the Interpretation of Agricultural Production Research," *Review of Marketing and Agricultural Economics*, Vol. 42, No. 3, Sept. 1974.
- APRACA (Asian and Pacific Regional Agricultural Credit Association)**, *Crop Insurance for Asian Countries*, FAO, Bangkok, Nov. 1980.
- Gavan, J. D. and Chandrasekera, I. S.**, *The Impact of Public Foodgrain Distribution on Food Consumption and Welfare in Sri Lanka*, Research Report No. 13, International Food Policy Research Institute, Washington, D.C., Dec. 1979.
- Hazell, P., Bassoco, L. M., and Arcia, G.**, "Insurance and Farm Cropping Studies in Mexico and Panama," IICA/IFPRI Conference on Agricultural Risks, Insurance, and Credit in Latin America, San Jose, Feb. 8-10, 1982.
- Kada, R.**, "Crop Insurance in Japan," a report submitted to FAO, Bangkok, May 1979.
- Kramer, R. A.**, "The Historical Development of Federal Crop Insurance," SP-14-81, Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Dec. 1981.
- _____ and Pope, R. D.**, "Participation in Farm Commodity Programs: A Stochastic Dominance Analysis," *American Journal of Agricultural Economics*, Vol. 63, No. 1, Feb. 1981.
- Maurice, N.**, "Status of Crop Credit Insurance Project," U.S. Federal Crop Insurance Corporation, Washington, D.C., June 1981.
- Mayet, P.**, *Agricultural Insurance in Organic Connection with Savings Banks, Land Credit, and the Commutation of Debts*, Swan Sonnenschein and Co., London, 1893.
- Meyer, J.**, "Choice Among Distributions," *Journal of Economic Theory*, Vol. 14, No. 2, April 1977.
- Oury, B.**, "Weather and Economic Development," *Finance and Development*, No. 2, 1969.