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Symposium on "Statistical Issues in National Agricultural Insurance Scheme"

Chairman: Prof. Prem Narain
Convenors: Dr. A.K. Srivastava
Shri D.K. Trehan

The Chairman introduced the topic and emphasised the role and importance of statistics in Crop Insurance in general and NAIS in particular. He recollected the role of Indian Society of Agricultural Statistics in the conduct of Comprehensive Crop Insurance Scheme (CCIS) in late eighties. It was pointed out that many statistical issues relating to premium rating, indemnity determination and crop yield estimation for assessing the losses at area unit level were tackled at that stage. Some research problems emanating from the practical experience were also tackled by M.Sc. and Ph.D. students at that time.

Dr. Srivastava, one of the convenors, presented the background of the symposium and discussed about papers invited in the symposium from different organisations involved in the planning and implementation of NAIS.

Following papers were presented in the symposium:

1. Role of yield data in National Agricultural Insurance Scheme — *B.M. Sharma*
2. Actuarial premium rating in crop insurance — *K.N. Rao*
3. Statistical issues in premium determination in crop insurance — *Shivtar Singh*
4. An approach for estimation of crop yield at Gram Panchayat level for National Agricultural Insurance Scheme — *A.K. Srivastava & Anil Rai*
5. Application of G.I.S. and Remote Sensing in crop yield estimation – Crop Insurance perspective — *Anil Rai, Randhir Singh & A.K. Srivastava*

Mr. Trehan one of the convenors, Mr. S.D. Chopra and Dr. Rajiv Mehta could not participate in the symposium due to their engagements at Delhi, however, the papers of Mr. S.D. Chopra and Dr. Rajiv Mehta were highlighted by one of the convenors.

Following recommendations emerged from presentation of papers and discussions held in the symposium:

1. In the NAIS, area unit level has been reduced from Block level to Village Panchayat level. The pros and cons of reducing the area unit level with respect to availability of estimates, at that level, of different crops under NAIS as well as with respect to assumption involved should be examined.
2. The approach of farmer's estimates for developing crop yield estimates at Village Panchayat level should be attempted with caution. Issues like assumption involved, acceptability of the approach and risks relating to response biases should be addressed at a pilot level.
3. Since interests of farmers are involved in the crop insurance, any methodology must be insulated from the pressures due to interests of stake holders. A continuous vigilance mechanism to maintain the reliability of the system must be an integral part of the approach.
4. Any approach to obtain the crop yield estimates at V.P. level should ensure that it does not have any adverse effort on the system of agricultural statistics.
5. In the farmer approach, besides obtaining yield information from farmer, related information from other experts should also be collected and appropriately utilised.
6. In the actuarial framework of crop insurance, at present the temporal yield variability is accounted for in premium determination. Keeping in view the risks and variability existing at spatial level, the spatial variability should also be accounted for in premium determination. Some research studies for this purpose may be needed which should be taken up.
7. With respect to application of remote sensing in NAIS context, issues relating to spatial regression and prediction models need to be addressed. Studies need to be carried out for RS and GIS applications to NAIS which should be integrated with the existing system of NAIS.
8. Crop insurance has got human and legal dimensions. Any viable alternative must have the objectivity and firmness to deal with legal aspects and it must have the human approach and confidence of the people for its wider acceptability.

Role of Yield Data in National Agricultural Insurance Scheme

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The yield data as generated under General Crop Estimation Surveys (GCES) has been used for macro level planning and production estimates since long, it is relatively recent that the yield data is being used for deciding compensation under crop insurance schemes. It is with introduction of Pilot Crop Insurance Scheme in 1979 and subsequently the Comprehensive Crop Insurance Scheme (CCIS) in 1985 which gave new dimension to the yield data generated under GCES. It is for the first time under Crop Insurance Schemes, the short fall in yield as decided based on GCES estimates, is converted to money in terms of compensation payable. In other words, the yield data assumed significance in view of its linkage with compensation under Crop Insurance Schemes.

While the primary purpose of yield data under CCIS was to decide the compensation, it gained more significance under National Agricultural Insurance Scheme (NAIS) due to its relevance in various other aspects of the scheme. The role of yield data in NAIS can be considered in the following areas :

(a) Payment of compensation :
  I. Fixing of Indemnity Limits
  II. Fixing Threshold Yield
  III. Determining shortfall in yield
(b) Arriving actuarial premium rates
(c) Fixing maximum sum-insured limits

Let us have look at the details of each of the areas.

(a) Payment of Compensation :

I. Fixing of Indemnity Limits - As per the Scheme provisions three levels of indemnity has been fixed, viz. 60%, 80% and 90% corresponding to high, medium and low risk crops / areas. The Indemnity Limits vis-a-vis the variability in yield based on preceding 10 years' yield data are given in the table :

Coefficient of variation	Risk group	Indemnity Limit
Upto 15%	Low risk	90%
>15% and upto 30%	Medium risk	80%
>30%	High risk	60%

In practice, since the indemnity limits are fixed State as a whole, the majority principle is used to fix one indemnity limit at State level. In other words, the number of strata falling under each of the risk group shall decide the indemnity limit to be given at State level.

II. Fixing Threshold Yield - The threshold yield is average of past three or five years yield multiplied by the level of indemnity. In case of Paddy and Wheat, the average is based on past three years and for rest of the crops, it is based on five years. Threshold yield is also known as Guaranteed Yield and is a moving / rolling average.

III. Determining Shortfall in Yield - Shortfall is the difference between the threshold yield and the actual yield recorded during the season.

(b) Arriving Actuarial Premium Rates

Normal distribution method is being used to determine the pure premium rate under NAIS. Shri N.G. Pai, the consultant Actuary of NAIS recommended premium rating based on normal distribution which presumes that "irrespective of the population, the sample mean will always follow normal distribution". Shri Pai prepared readymade table of premium rates at various levels of indemnity corresponding to coefficient of variation (c.v.). As per the table, premium rate will go up with increase in c.v. and further the rates will be high at higher levels of indemnity.

(c) Fixing Maximum Sum-insured Limits

The NAIS is compulsory for farmers availing crop loans from Financial Institutions and is optional for others. The compulsory element in case of loanee farmers is applicable to the extent of amount of loan availed while in case of non-loanee farmers, the insurance coverage is given upto value of the threshold yield. Both, for loanee and non-loanee farmers the sum-insured can be extended upto the value of 150% of average yield on payment of premium at commercial rate for sum-insured exceeding value of threshold yield.

In the light of the multi-dimensional use of yield data in the NAIS, the accuracy of data under GCES assumes greater significance. While the GCES prescribes levels of accuracy required at different strata, statistically and

operationally the system should be strengthened so as to maintain required levels of accuracy as desirable under NAIS. The conversion of shortfall into money as is done under NAIS is open to manipulations and pressures by vested interests, unless proper supervisory mechanism is developed. The multi-picking crops offer more scope for manipulation, unless steps are taken to streamline and strengthen the procedures.

Some of the flaws noticed by GIC in the course of witnessing of CCEs under CCIS are as follows:

1. Primary workers in many cases are not aware of system of conduct of CCEs, including selection of plot.
2. Crop cutting kit is in short supply in many States and those who have the kit hardly carry it to the field at the time of conduct of CCEs,
3. Many a time experiment is not conducted on the date confirmed few days earlier by the primary workers.
4. The produce separated for driage experiment in many cases is left to the care of farmers rather than managed by the primary workers.
5. There were many instances where the primary worker claimed to have conducted the experiment, while the farmer is unaware of any experiment being conducted in his field.
6. The absence of village map / "naksha" and delay in land record enumeration make it difficult in selection of the plot and supervision.

Actuarial Premium Rating in Crop Insurance

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1. Premium rating techniques in the commercial insurance industry are intended to develop a price structure adequate to cover claims and the operating costs of the insurer and provide a reasonable profit while not being so high as to be noncompetitive. While in case of NAIS, it is intended to work on "no profit and no loss" basis. The secondary objectives of premium rating system are:

Stable — The technique normally incorporates stability, especially for a product that is subject to infrequent occurrences of extremely severe events.

Responsive — The technique should be responsive to changes in loss exposures. In some respects, responsiveness and stability are competing objectives. However, both must be pursued.

Provide for contingencies — The technique should include some loading for the unknown and unknowable.

Encouragement / Incentive to insured — Since premium rates are driven by expected losses, they can be made more affordable only if insured persons retain incentives to avoid losses when possible or to minimize the amount of loss, when it occurs.

Appropriately discriminatory — To be effective, premium rates must be appropriate for the risk that is presented.

2. Most insurance literature identify three generic methods for rate making:

(a) Judgement — This is the oldest method, in which the intuition of the rate maker plays a major role in setting the rate. It is very useful in setting a rate for a new crop, as reliable data for an extended historical period rarely exist.

(b) Loss ratio — Simply put, the losses paid to by those policyholders are summed up and then divided by the sum of the premiums paid by those policyholders expressed on current rate level. It is a method for adjusting an existing premium rate.

(c) Pure premium method (Loss cost) — It is a ratio of the losses paid to policyholders divided by the insurance provided to those policyholders. The pure premium method calculates a new premium rate each time it is used whereas the loss ratio method adjusts a previously established premium rate.

Besides the above, new set of methods based on mathematical or statistical modeling for losses occurring very infrequently with extremely unpredictable magnitude are also used as sophisticated techniques.

3. As per UNCTAD document on "Agricultural Insurance in Developing Countries" a standard Actuarial model for calculating the premium for crop insurance has not yet been developed. The document further states that specific formulae have been developed in different countries depending upon the parameters and variables of their programmes.

The various methods which are used world over are:

(a) The USA method: Essentially based on the idea that the set of seasonal crop yields obtained for a defined area during a representative period in the past will be repeated over a similar period in the future.

(b) The MPD method: Mean Percentage Deviation (MPD) takes into account every variation in the yield which occurs during the period and is expected to provide a stable estimate of the seasonal variability and consequently of the premiums which can be derived from such estimates.

(c) Dandekar model: Similar to MPD except that Dandekar used Mean Deviation in place of Standard Deviation.

(d) Normal Curve Technique (NCT) : It is based on the assumption that the average yields will follow normal distribution due to Central Limit Theorem, which states that whatever may be the parent distribution, the distribution of sample means is normal.

(e) Pearson Curve Technique: Based on Pearson distribution which is a function of skewness and kurtosis.

4. In addition, the available limited literature tells that premium can also be determined based on Non-parametric density methods like Histograms, the Naive Estimator and the Kernal Estimator. It has been learnt that, earlier during 1992, Ms. Geetha Lakshmi at Indian Agricultural Statistics Research Institute (IASRI) had done her thesis of Master of Sciences (Statistics) on Actuarial premium rating on Crop Insurance program and later she went on to complete her Doctorate in Statistics.

5. The author of this paper had met Dr. Geetha Lakshmi at Avikanagar (Rajasthan) during 1998 to discuss the details of methodology used in her study. She explained that almost all the parametric methods used are based on certain assumptions related data distribution etc. and sometimes these assumptions can go wrong giving less than perfect results. The method devoid of these assumptions totally or rigid assumptions is Non-parametric method, although there is no proof of it's usage in Crop Insurance premium rating. She told that the project was given to her through Dr. Prem Narain, who was Director of IASRI in the eighties and early nineties.

6. Some of the Non-parametric density methods which can be utilized in calculation of premium rates are Histograms, the Naive Estimator and the Kernel Estimator. Dr. Lakshmi had selected Kernel Estimator method and she had worked out premium rates by using two different Kernels, viz. Epanechnikov and Gaussian and compared the results with those worked out by NCT, a parametric method. She went on to compare the results of all the above three methods based on Percentage Standard Error (PSE) of Indemnity. She has statistically proved that PSE of Non-parametric method is less than that of NCT and concluded that Non-parametric method is better than parametric methods.

7. Shri N.G. Pai consulting Actuary for NAIS, on request from GIC studied some of the premium rating techniques and recommended in favour of "fitting past yield data into Normal distribution with a view to projecting the future risk premium". The method is also called Exposure Rating Method based on the statistical assumption of Normal distribution, i.e. irrespective of the population, the sample mean will always follow Normal distribution. As per Shri Pai, this method is also used in other countries. On the basis of this technique, Shri Pai has prepared readymade table of premium rates at various levels of indemnity corresponding to coefficient of variation, for simple use.

8. The technique is very useful where the data fits into Normal distribution, but the same can not be said, if the data fitting is not proper, e.g., the technique has not considered linear trend in the data. Further, if there are two areas which had same productivity of a particular crop 10 years ago, but one showing increasing trend and the other showing decreasing trend at the same rate in the last 10 years, will now receive almost same premium rating under this technique. However, the chances of claims being paid is much more in case of area with decreasing trend and almost non-existent in case of area with increasing trend.

9. A premium rate is only an estimate of the future requirements to pay losses. There is no such thing as "the one and only true" premium rating technique and rate. Though, the techniques used in countries like USA, Spain, Japan etc. by and large are from the same generic background, but are refined by use of modeling techniques and additional data on weather parameters. Well, under NAIS, it may be justified to begin with technique based on Normal distribution, but the accuracy and success of premium rating in future lies in refining the technique based on inputs from other techniques / countries and based on our own judgement.

10. The premium rating technique produces only pure premium rate, whereas the final commercial rate charged normally includes loading in respect of (1) reserve for unexpected heavy losses (2) administrative cost (3) moral hazard (4) anti-selection (5) escalation in scale of finance/sum insured (6) inconsistency in yield data and (7) profit margin etc.

The suggested loading for an illustration can be as follows:

(a) Escalation in scale of finance / sum insured – 10%

(b) Data inconsistency * – 5% for each year
(but not exceeding 20% for the parameter)

(c) Reserve for future heavy losses – 10%

(d) Anti-selection – 5%

(e) Moral hazard – 5%

(f) Admn. expenses – 5%

(g) Profit margin – 5%

*Data inconsistency indicates non-availability of certain years yield data at a given insurance unit level out of past 10 years, necessitating adoption of parent unit' data for those years.

Statistical Issues in Premium Determination in Crop Insurance

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Farmers in India continually face risks in crop production right from the time of sowing to harvesting. Floods may wash away growing fields, droughts may wither plants, diseases and pests may attack during crop growth and rain or hailstorm may wipe out months of farmers' labour and likely production in a single stroke. Crop insurance is a technique of protecting the farmers from such risks. Under crop insurance by paying small amounts as premium, farmers purchase the right for compensation in the event of crop failure. Moreover, the liability of the Government to bear the cost of relief measures to the farmers following crop failure is reduced to some extent as through crop insurance the farmers themselves contribute to their own relief.

This paper is based on a project completed at IASRI, in which the statistical issues namely variation in yields, their distributions, determination of premium rates by well known methods and their comparisons, have been discussed. Data collected in the Comprehensive Crop Insurance Scheme (CCIS) implemented by the Government of India and operated through the General Insurance Corporation of India (GIC) with the active involvement of the State Governments and Union Territories were used.

The ten-year yield data of paddy and wheat crops available for the defined areas in the States of Bihar, Madhya Pradesh, Uttar Pradesh and West Bengal were used to test normality. The premium and indemnity tables were prepared following Dandekar's Mean Percentage Deviation Method (MPD), Normal Curve Technique, Square Root Transformation, Logarithmic Transformation and Type I Pearson method for comparison of the procedures. However, the MPD

method was used for working out the premium rates at 80 per cent level of coverage, utilizing 5 years taluk/block yields for the period ending 1985-86 from 12 states for paddy crop, 10 states for wheat, 7 states for millets, 6 states for oilseeds and 9 states for pulses. These rates for a crop in a state were pooled to get the statewise average rate.

The premium rates in a given homogeneous defined area depend on two parameters : (i) year to year variability in the average annual yield (measured in terms of coefficient of variation) and (ii) the level of coverage. The actuarial premium rates are directly proportional to these parameters. Larger the variability, higher is the premium for a fixed level of coverage. Alternatively higher the level of coverage, higher is the premium for a fixed level of variability.

The CCIS was based on area approach. The premium rate was kept fixed, 2 per cent for paddy, wheat, and millets and one per cent for oilseeds and pulses. The threshold yield was 80 per cent of the average yield in the defined area. Claim, if any, was payable to all insured farmers uniformly and it was equal to the short fall in yield for the defined area during an insured season for an insured crop. The average yield of a crop for a given area was based on at least 16 crop cutting experiments (CCE).

It may be mentioned that the Indian Society of Agricultural Statistics (ISAS) was actively associated with the CCIS. In fact, GIC had given consultancy work including the work of preparation of premium-indemnity tables for the CCIS during the first three years of its implementation to the Society. A symposium on crop insurance was organized in 1985 during the 39^{th} Annual Conference of ISAS. The author was the convenor of that symposium and also presented a joint paper, which in sum indicated that as the CCIS was not self-supporting, the Union Government should be prepared to contribute a large sum to the insurance fund if CCIS is to take off. The claims paid under the CCIS during the first year of its operation confirmed the above conclusion.

The distribution of crop yields in the defined crop strata was tested for normality by Shapiro Wilk test at 5 per cent level of significance. It was seen that out of 529 crop strata, the normality was positive in 59 cases for paddy and in 24 cases out of 411 crop strata for wheat. The empirical findings thus showed that distribution of crop yields need not be normal. Crop strata in which the test of normality was negative were further tested for normality after applying square root and logarithm transformations of crop yields. The results indicated that these transformations were not of much help to transform the yield data to normality.

Pearson system of distributions was tried on crop yields in the unit of insurance. It was found that 80 per cent of crop strata for paddy as well as wheat followed Type I Pearson distribution and 15 to 17 per cent of crop strata confirmed Type II Pearson distribution. Only one per cent of crop strata showed a normal distribution.

Premium rates did not vary much among themselves based on normal curve technique, USA method and as worked out by Mean Percentage Deviation (MPD) method. However, premium rates estimated by Type I Pearson curve and regression techniques were lower than those estimated by other techniques. The crop strata not following normal distribution over estimated the premium rate in comparison to Type I Pearson distribution. The reduction in premium in regression technique was due to the fact that a part of variation due to systematic trend in crop yields was removed in premium estimation. The MPD procedure was preferred in premium estimation because of its simplicity in practical application and also due to accounting the variation in crop yields, which is not so in USA method. Further, it avoids estimation of parameters as is being done in normal curve and Type I Pearson techniques for each crop strata. The MPD procedure had been used in premium determination in this investigation.

The average premium rate at 80 per cent indemnifiable limit in 1985-86 at All India level was estimated at 5.3 per cent for paddy, 5.5 per cent for wheat, 9.1 per cent for millets, 9.3 per cent for oilseeds and 8.6 per cent for pulses. The corresponding figures at 90 per cent indemnifiable limit were 7.7 per cent for paddy, 7.9 per cent for wheat, 12 per cent for millets, 12.2 per cent for oilseeds and 11.4 per cent for pulses. The premium rates were more or less of the same order in the year 1986-87.

The premium rates for paddy at 80 per cent indemnifiable limit in the year 1985-86 ranged from 2.7 to 3.3 per cent in Bihar, Kerala, U.P., A.P. and Assam; from 4.7 to 8.5 per cent in West Bengal, Tamil Nadu, Orissa, Madhya Pradesh, Karnataka and Maharashtra, however, premium was 13.2 per cent in Gujarat. For wheat crop, the rates ranged from 1.2 to 4.4 per cent in U.P., Bihar, Assam, West Bengal and Gujarat; from 5.3 to 9.4 per cent in Rajasthan, Madhya Pradesh, Maharashtra and Himachal Pradesh except Karnataka (11.9 per cent). In the case of millets the premium rates were high ranging from 6.0 to 15.8 in Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Karnataka, Maharashtra and Gujarat. The premium rates for oilseeds were also high, the lowest in Bihar (5.7 per cent) and highest in Karnataka (14.6 per cent). These rates for pulses varied from 4.2 to 4.8 per cent in Bihar, U.P. and Assam and 7 to 9.8 per cent in Gujarat, Madhya Pradesh, Andhra Pradesh, Rajasthan and

Maharashtra. Karnataka state had the highest premium rate of 17.0 percent for pulses.

Variability in crop yields was observed to be more in millets, oilseeds and pulses as compared to paddy and wheat crops. Negligible percentage of crop strata had coefficient of variation less than 5 per cent for all crops. Majority of crop strata had coefficient of variation more than 20 per cent particularly for millets (73%), oilseeds (72%) and pulses (67%). Stability in crop production was noticed for wheat and paddy crops only.

Distribution of crop strata according to premium rates showed that in 39 per cent of crop strata for paddy, 43 per cent of strata for wheat, 19 per cent of strata for each of millets and oilseeds and 24 per cent of crop strata for pulses, the premium rates were upto 2 per cent at 80 per cent level of coverage. In a large number of crop strata the estimated actuarial premium rates were more than the flat rates charged in the CCIS. This implied that CCIS lacked actuarial soundness and would involve heavy losses from year to year. A further examination of variability in actuarial rates between states and between crop strata within a state for different crops revealed that a larger proportion of the total variability in premium rates ranging from 70 to 90 in 1985-86 was accounted for between crop strata within states. This implied that differential rates of premium for different crops would be more meaningful than flat rates.

The criterion of fixing the threshold yield at 80 per cent of the average yield was debated in the course of implementation of the CCIS in the states. Some of the states willing to join the scheme suggested to raise the level of coverage from 80 to 90 per cent. The progressive states with assured irrigation facilities had even claimed that the level of coverage could be as high as 100 per cent. The suggestions made by the states were examined both theoretically as well as empirically. Assuming crop yield to follow normal distribution with mean 'm' and standard deviation 'σ', the premium rates defined as average indemnity expressed as percentage of the threshold yield were calculated for coefficient of variation (CV) ranging from 5 to 40 per cent and indemnity limits varying from 65 to 100 per cent. It was seen that the raising of threshold yield to 100 per cent even in most progressive states would not be possible as 5 per cent CV may be obtainable in very few crop strata. It was perused that in broad five categories viz. CV less than 5 per cent, 5-10 per cent, 10-15 per cent, 15-20 per cent and more than 20 per cent, the level of coverage would respectively be 100, 95, 90, 85 and 80 per cent. This criterion for level of coverage would only apply for paddy and wheat and not for millets, oilseeds and pulses in which case it would be only 80 per cent. It may be mentioned that for determination of coefficient of variation in yield, the calculation of

variation should take into account technological trend if found significant on the basis of at least 10 years yield data. Since CV would be on the basis of 10 years moving average for each crop strata, it should be calculated afresh every year before determining the level of coverage. An empirical study for the possible level of coverage using 10 year data on the above referred basis ranged between 80 to 90 per cent in a good number of crop strata in 9 states for paddy and 3 states for wheat.

It has been agreed upon in CCIS that average yield of a crop in a crop strata should be based on at least 16 crop cutting experiments (CCE). However, when the number of CCE conducted in a defined area was less than 16, it was suggested that the area may be clubbed with the adjoining area(s) such that the number of CCE is 16 or more and the average yield was calculated as if both the areas form a single homogeneous unit.

It is heartening to note that keeping in view the welfare of the farmer and his family, the Government of India has announced National Agricultural Insurance Scheme (NAIS) ignoring the huge claims paid in the implementation of CCIS. It may be relevant to mention that the amounts of insurance protection and premium rates should be determined not only by technical considerations alone namely the average yield of a crop and its crop loss probability but also by economic and social considerations like paying capacity of the farmers, the resources that the Government is willing to allocate as also the desirability and feasibility of income transfer from non-agricultural to the agricultural sector.

Crop Insurance as a Measure of Risk Management in Agriculture

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Risk and Uncertainty

Risk and uncertainty are generally used synonymously and the events involving any one of the two relate to the future. But from the economic point of view, they are considered different from each other. Some events can be predicted at least in probabilistic terms. These occurrences can be foreseen on the basis of past experience. Such events are said to involve risk and not uncertainty. In other words, all risks are uncertain, but all uncertainties are not

strictly risks. Only uncertainties which can be concretized into specific happenings - past, present or future - can be covered by Insurance. According to Wallat existence of uncertainty is the fundamental condition for the existence of insurance. But uncertainty in abstract form is the state of mind of the individual which correspond to the degree of probability of an occurrence (or chance) in the objective situation. Thus, Uncertainty is a function of probability.

From insurance point of view, probabilities can be divided into three categories : first, those in which a definite mathematical expression of probability can be attained in advance of the occurrence of the uncertain event; second, those in which probability can be obtained in advance and third in which no method of obtaining probability exists.

Risk Management Measures

In order to cope with these risks, farmers and rural societies have developed a range of risk management measures. These can be classified into Risk-reducing and Risk-coping Strategies.

Risk-reducing strategies include crop diversification, inter-cropping, farm-fragmentation and diversification into non-farm sources of income. Crop-sharing arrangements in land renting can also provide an effective way of sharing risks. Risk-reducing strategies can be effective in addressing many production and market risks. But while they help to stabilize family income, they are typically costly for those with average income because they require that farmers forego their most profitable alternatives. For example, crop diversification is usually less profitable on average than crop specialization and land fragmentation imposes costs in the form of labour and transport inefficiencies.

Risk-coping strategies are relevant for dealing with catastrophic income losses once they occur. Under such circumstances farmers may need new credit (especially consumption credit) the sale of assets, or temporary off farm employment. Risk-coping strategies also prove costly to the farmers. The sale of assets for example affect adversely the long-term growth of a farm business. The loans raised during time of occurrence of catastrophic losses are required to be repaid. And if it is raised from informal sources then it will be quite at a higher rate of interest.

But a more fundamental problem with traditional risk-coping strategies is that they can not deal effectively with the co-variability problem that characterizes most agricultural risks. For example, production and price risks affect nearly all farmers simultaneously in a region. Many farmers seek

consumption credit, at the same time, thereby driving up local interest rates. Similarly, local wages are driven down by a surge in the labour supply, and the value of farm assets declines as too many farmers try to sell at the same time. Once the crises is over, farmers will find it difficult to replace assets as prices are generally go up again because of competition. For co-variate risks, local risk-coping strategies need to be reinforced by risk pooling arrangements that cut across one region to another. Here lies, in fact the role of Crop Insurance which covers all regions of the country.

By means of Crop Insurance, the farmers can insure himself against certain chance of occurrence of crop loss due to weather hazards, insect infestations and diseases. Crop Insurance can be classified into several categories:

(i) Single peril or Multi-peril Crop Insurance

(ii) Individual farm based or area based Crop Insurance

(iii) Specific crop or all crops based Crop Insurance

(iv) Voluntary or Compulsory Crop Insurance

Introduction of NAIS

In view of the limitations in CCIS, the scheme has been modified so as to enlarge its coverage in terms of farmers, crops and risks. From Rabi 1999-2000, a new scheme called 'National Agricultural Insurance Scheme (NAIS) has been introduced in place of CCIS.

NAIS covers all farmers-loanee and non-loanee both irrespective of their size of holding. It envisages to cover all food crops, oilseeds and annual commercial/horticultural crops in respect of which past yield data is available. The new scheme is proposed to cover higher level of risk i.e. sum insured upto the value of threshold yield and required to operate at a lower unit of insurance (*i.e.* within a period of three years implementing States are required to reduce unit of insurance to Gram Panchayat). To bring about some amount of financial viability in the scheme premia - structure in the new scheme has been rationalized. Main features of NAIS has been annexed.

Conclusion

Whatever improvement we make in designing the crop insurance scheme, one thing should be clearly understood, wherever crop insurance has been implemented by the public agencies/Govt. bodies up till now, it has been proved financially un-viable. There are various reasons for this. Firstly, Public Crop Insurance Schemes generally try to cover un-insurable risks which occur

frequently and the required premiums are too high for most of the farmers (small and marginal farmers) to pay. Secondly, where there are large number of small and marginal farmers scattered over the country, administration cost will be very high. Again, if the Government decides to guarantee the financial viability of the insurer, it may further aggravate the situation as sound insurance practices may not be pursued by the insurer as he is nothing to loose.

Crop Yield Variability and Actuarial Framework of Crop Insurance — An Analysis of Pearl Millet

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Introduction

The economic activities are often subjected to financial risks occurring due to uncertainties of the factors governing the production. The extent of risk depends upon the parameters which are beyond the human control. Often, these parameters are dominated by natural and climatic phenomenon. The preponderance of climatic and natural phenomenon on the agricultural activities enhances the variability of production and thus increases the risk. The failure of crop due to drought, floods, pests and other such factors is a common feature for the agricultural sector. Generally, the farming community in India has a very weak risk bearing capacity due to scares resources and small holdings. This, in turn, makes them a vulnerable section of the socio-economic strata of the society. To safeguard the interests of the farmers from crop losses over space and time and to provide social security, self-help, encouragement for larger investment and increase in agriculture production, the Comprehensive Crop Insurance Scheme (CCIS) was initiated in 1985. The National Agricultural Insurance Scheme (NAIS) launched during the year 2000 has strengthened the scope and coverage of earlier crop insurance scheme.

For the viability and the benefits, it is essential that the crop insurance programme should be actuarially sound. This requires an in-depth study of probability distribution of the variability on which indemnities are based. The actuarial approach for crop insurance is area based and it takes into account the variation in yield over time. The criterion for indemnities are linked to yield averaged over time. This, however, does not take into account the spatial