Improving the effectiveness and acceptability of the Federal crop insurance program
by Dana H Myrick

A Thesis Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY in Agricultural Economics
Montana State University
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Abstract:
The Federal Crop Insurance Corporation is a government-operated business-like firm, born in 1938 after 16 years of Congressional debate and research. The FCIC offers an insurance service under contracts purchased, voluntarily by farmers. It is obligated to charge premiums that will cover loss indemnities paid under the contracts over some period of years.

The Corporation is akin to private insurance firms in several ways': The FCIC must develop a sound actuarial system. It must define insurance groups, build high participation, avoid adverse selectivity, and employ the tools of underwriting and merit rating to achieve the purpose for which the Federal Crop Insurance Act was initially designed. It is entrusted with the management of accumulated reserves.

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The Federal crop insurance program must cope with the problems of insurance imperfections, such as lack of homogeneity among insured, and non-random effects on losses (such as differences in management, farm size, and soils). The FCIC has developed size and experience-credit formulas to take account of these non-random differences between insureds. Consideration should be given to the reformulation of experience and size credits to accomplish merit-rating purposes. An improved merit-rating system could make possible the use of larger rate areas, defined by pronounced topographic and geological differences. Methods will need to be devised for rating large units as the program is adjusted to the major trend toward larger and fewer farms.

A new federal farm program, beginning in 1964, provides participating farmers with part of the function of crop insurance, by guaranteeing an income regardless of crop yields through its certificate plan. This program will have an effect on the participation in the Federal crop insurance program and upon its actuarial data.

Attention is called to the relatively short history of the crop insurance program, to the social investment (including a public financial investment of $200,000,000), and to the progress the FCIC has made toward achieving its goal. Further attention is called to the disturbance to insureds and farmers caused by conflicts between agencies, and by annual changes in program policy.

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ABSTRACT

The Federal Crop Insurance Corporation is a government-operated business-like firm, born in 1938 after 16 years of Congressional debate and research. The FCIC offers an insurance service under contracts purchased voluntarily by farmers. It is obligated to charge premiums that will cover loss indemnities paid under the contracts over some period of years.

The Corporation is akin to private insurance firms in several ways: The FCIC must develop a sound actuarial system. It must define insurance groups, build high participation, avoid adverse selectivity, and employ the tools of underwriting and merit rating to achieve the purpose for which the Federal Crop Insurance Act was initially designed. It is entrusted with the management of accumulated reserves.

Drouth is the most important peril covered. Precipitation records indicate that an actuarial period of at least 20 years is required for a sound rating program covering the major crops. Since the Federal crop insurance program was placed on an experimental basis in 1947, it has not yet completed one actuarial period, even on wheat, the first crop insured. Whereas the drouth peril does not occur randomly from year to year, even over large geographic areas, annual and even ten-year loss ratios of individuals, counties and states are not representative of their long-term loss expectancies based on a "complete" weather cycle.

The Federal crop insurance program must cope with the problems of insurance imperfections, such as lack of homogeneity among insured, and non-random effects on losses (such as differences in management, farm size, and soils). The FCIC has developed size and experience-credit formulas to take account of these non-random differences between insureds. Consideration should be given to the reformulation of experience and size credits to accomplish merit-rating purposes. An improved merit-rating system could make possible the use of larger rate areas, defined by pronounced topographic and geological differences. Methods will need to be devised for rating large units as the program is adjusted to the major trend toward larger and fewer farms.

A new federal farm program, beginning in 1964, provides participating farmers with part of the function of crop insurance, by guaranteeing an income regardless of crop yields through its certificate plan. This program will have an effect on the participation in the Federal crop insurance program and upon its actuarial data.

Attention is called to the relatively short history of the crop insurance program, to the social investment (including a public financial investment of $200,000,000), and to the progress the FCIC has made toward achieving its goal. Further attention is called to the disturbance to insureds and farmers caused by conflicts between agencies, and by annual changes in program policy.

CHAPTER I

INTRODUCTION

The Problem

The Federal Crop Insurance Corporation celebrated its Twenty-Fifth Anniversary in 1964. The program was conceived in the agricultural stress of the 1920's and born amidst the agricultural crisis of the 1930's. There are differing opinions as to who or what was the father, from whence came the urge, and why the nurses have so desperately worked to keep the baby alive. There have been those who sincerely believed that crop insurance was a response to the demand of the farmers. Others would argue, just as sincerely, that it was a part of the plans of the Administration to meet the emergency needs of agriculture--a supplement to or substitute for relief measures. There are undoubtedly those who now feel that it is just another government bureau which desperately strives to perpetuate itself.

Twenty-five years of experience should provide a base from which the program may be viewed with a better chance of gaining some perspective of its accomplishments, its problems, and future plans for meeting its problems and attaining its objectives. Three stages in the Federal crop insurance program are now discernable:

Stage One is characterized by the trials and errors of an experimental model. It incorporated from previous models whatever appeared to have been acceptable features. The rest of the model was conceived on the drawing board, based on theory combined with results of experiments on various parts. More specifically, the crop insurance program made use of research studies and the experience of private insurance companies. One reason the private experiments failed was because they included price protection, a feature which was avoided in the government program. They also failed because of lack of capital, and because it was not feasible to base premiums on a sufficiently long actuarial period. This, more than anything else, was responsible for the private support of the governmental experiment, which could incorporate sufficient capital and provide the

opportunity to carry out experiments over a long period. The specifications for the new experimental model called for features relating to goals other than insurance. Emergency relief, and price and income instability were major concerns of the administration. Thus, commodity storage and political pressures influenced the design of the first program. Stage One included the shake-down tests of the new model, characterized by some narrow escapes, and finally an almost disastrous crash, when Congress failed to appropriate funds for continuation of the program in 1943. An overall view of Stage One reminds one of wartime production, where the emergency situation precludes the setting up of a well-planned experimental program, and forces production before the model is properly tested. It is pointed out in Chapter 3 that one of the early mistakes in developing the Federal crop insurance program was that, whereas the intention was to go slowly and experiment with one crop at a time, political pressures dictated otherwise.

Stage Two began with the revival of the crop insurance program on a planned experimental basis in 1947, when the program was set up on a planned-growth projection, and experienced insurance personnel were enlisted in the development and administration of the program. Sales development was finally given a prominent place in the plans.

Stage Three of the Federal crop insurance program begins with what some individuals hope is the launching of the second twenty-five years of all-risk crop insurance. This stage will be affected by the impact of the rapidly changing agricultural situation in the United States. The average size of farms is rapidly increasing, resulting in a rapidly decreasing political power of agriculture. Just as important is the rapid shift from labor to capital in all of agriculture. There is also the effect of some pertinent changes in other Federal agricultural programs, which directly affect Federal crop insurance. The growing emphasis of the Administration on budget economy will have its impact on the future of the program, forcing it to justify more forcefully than ever its existence and continuation.

This latter situation is the problem for the FCIC. Up to this point in the Federal crop insurance history, Congress has judged that the marginal returns from public money invested in crop insurance are comparable to the returns from the funds if invested elsewhere. As the whole structure of governmental expenditures is reviewed, all programs will be reexamined in the light of their accomplishments, and the possibilities of upgrading their operations--to increase their marginal returns per dollar invested. Some measures that will likely be used in the evaluation of the crop insurance program include the degree of participation in the program, administrative costs (now borne by the government) relative to total premiums, and need. Evaluation of the need would include an estimate of costs directly to the government and to society, of any effect which the absence of the program would have on production efficiency. The possibility of shifting administrative costs from the government to the FCIC would likely be explored. It is a matter of record that supporters of the original crop insurance act hoped that some day the program could be transferred to private insurance companies. This, too, may be explored. In October of 1964, at the annual convention of the National Association of Mutual Insurance Companies at Denver, the Crop Insurance Research Bureau was formed, "to tell the truth" about the FCIC. Max D. Rutledge, president of Farmers Mutual Hail of DesMoines, and head of the Bureau said that

> It is our intent to publicly challenge statements made by FCIC regarding its original purposes, its future intentions, its financial reports, its administration, its sales methods, its list of supporters, and its effect on the insurance business. 1/

Don W. Montgomery, outgoing president of the NAMIC, while he deplored the FCIC as a prime example of "government escalation," indicated that cooperation between government and private companies might be acceptable.

1/ Damman, George H., reporter, "NAMIC Concerned About Government Insurance Growth," The National Underwriter, October 23, 1964, page 1.

> But we also have other examples of what I believe constitutes a proper and effective relationship, such as the emerging pattern of business and government cooperation for special perils in such as atomic power coverage and foreign credit insurance. 2/

If these individuals are sincerely interested in public service, it follows that they would consider an alternative to Federal crop insurance, such as some cooperative arrangement with the government to provide all-risk crop insurance.

The Research Problem

The research problem is to attempt to find answers to the question: "What variations in the all-risk insurance program would increase its effectiveness and acceptability as a program and make it more nearly meet the needs of farmers?" The research will be concentrated on the program in Montana, with the assumption that solutions to the Montana problem will have some application to the total program for the United States.

Contemporary studies in other states are analyzing farmers' attitudes about insurance and other risk-bearing devices. A survey by the Economic Research Service, USDA, has analyzed the impact of the Federal crop insurance program in two areas, one in Virginia and one in Montana, where large indemnities were paid on the 1963 crop.

This study will reappraise the Federal crop insurance program in relation to the intended objectives and principles underlying insurance in general and crop insurance specifically. The objectives of the crop insurance program are stated in the implementing statutes. The question is, are the objectives still consistent with the needs of the farmers for protection and does the program meet the objectives?

The FCIC feels a need to expand its operations into new areas, to new crops, and expecially among more farmers. Expansion requires a study of coverage adequacy and rates, special area problems, and farmers needs.

2/ Ibid., p. 1.

There is the large general question of fitting the program into the changing agricultural situation. What new needs for crop insurance are being created, and what old needs are disappearing? How will changes in agricultural programs affect the needs for crop insurance? How can all-risk crop insurance be better integrated with other agricultural programs? It will be pointed out in subsequent chapters that crop insurance is no different from other insurance programs in that sound actuarial work must be based upon past experience, yet must project substantially into the future, depending upon the nature of the risks insured. Furthermore, in a dynamic society, all insurance must be adaptable to change.

Hypothesis

The hypothesis is that there are improvements that can be made in the crop insurance program which will make it more acceptable to farmers, and allow it to better accomplish the objectives for which the program was originally designed. It is expected that methods can be found which will better recognize the differences between insureds which are due to non-random characteristics such as management, size of farm, and soil differences. It is expected that methods can be found whereby crop insurances can be extended into crops and situations where it is not now available by making more use of known insuring devices. The present crop insurance administration can be expected to continue to expand its services and justify its existence only if it can continue to improve its administrative efficiency and its status as an insurance institution.

Procedure

The chapter on background theory and concepts provide a review of risk theory and the theory of insurance. Insurance is compared with other means of shifting the burden of uncertainty. Crop insurance in particular is compared with other insurance, bringing out the unique characteristics of the former with an analysis of perils and insurance requirements.

A search of the Congressional Record provides some answers to the question of what the Federal crop insurance program was intended to do,

as revealed by the debates, testimony, and research results presented during the 16-year Congressional gestation period that gave birth to the final act.

Major concerns of insurance institutions are the proportion of participation relative to the insurable population and the continuity of participation. Generally, an insurance institution finds itself in a decreasing-cost situation, such that added participation (ignoring sales cost) tends to decrease cost per unit of premium volume. Further, an increasing proportion of participation tends to improve the actuarial accuracy. Based on these assumptions, an analysis of participation in the Federal crop insurance program provides an indication of the program's success.

Frequent reference has been made during the history of crop insurance to over-insurance and restriction of coverage to "investment in the crop." Also a concern was frequently expressed regarding the adequacy of coverage provided under all-risk insurance programs. Comparisons of available coverage with costs of production provide answers to the question of adequacy and over-insurance.

The problem of establishing appropriate premium levels can be solved only by continuous research covering loss-causing perils and the characteristics of insured units. This study is concerned mainly with an analysis of the perils, particularly drouth, and the variability among insureds, as these factors affect the probability of indemnity payment, or actuarial work of the FCIC.

Merit rating, or recognition of individual differences between insureds, is a rating tool that can be used to take account of non-random factors affecting crop-loss probability. A study of its use in the crop insurance program reveals how merit rating might be used to better advantage in the development of the program.

The changes that have occurred in agriculture since the birth of the crop insurance act, and especially since the program was put on an experimental basis in 1947, have a critical impact on its mission and

justification for continuance. Of particular importance is the impact of other Federal programs which tend to assume some of the insurance function. An analysis of the impact of the changing American agricultural industry and programs should aid in adjusting the crop insurance program to the changes that have occurred and those to be expected.

The future of all-risk insurance may depend upon changes in the insurance institution itself. Alternative organization structures should be contemplated as possible means of better accomplishing the objectives of crop insurance as it fits into the future political and economic framework of the country.

Whether or not to buy insurance is only one of many economic choices with which farmers are faced. The decision-making processes of managers provide the basis for a lengthy dissertation in itself. But this study would not be complete without at least a brief look at decision theory as it might apply to all-risk crop insurance.

The summary reviews the most plausible ways in which variations in the all-risk insurance program would increase its effectiveness and acceptability as a program and make it more nearly meet the needs of farmers.

CHAPTER II

BACKGROUND THEORY AND CONCEPTS

This portion of the study reviews the relevant theories of risk, uncertainty and insurance. The purpose is to clarify the terms "risk" and "uncertainty" as they will be used in this study; to present the theory of insurance as a frame of reference for analyzing crop insurance problems; to compare insurance with other means of meeting risk; to compare crop insurance with other types of insurance as a clue to solutions for crop insurance problems; and finally to summarize the theoretical guides for the study.

Risk and Uncertainty

Definition

A general text on insurance, especially if it contains a section on theory, will have a chapter on risk and uncertainty. Uncertainty arises out of the failure of future events to occur according to expectations--out of errors in predictions. The results can be favorable or unfavorable. Risk on the other hand is most often thought of as the chance of future events occurring with results unfavorable to those expected. Schickele says that risk and uncertainty are very different things:

> Uncertainty is lack of knowledge about some specific future event; risk is my evaluation of how badly the actual event may affect me in my well-being when it occurs, and this evaluation influences my present action and planning.
>
> Risk always has an unfavorable connotation. It implies the possibility of a risk loss, but does not necessarily imply a corresponding possibility of a risk gain. 1/

Schickele does not mean to imply that there are no risk gains, but rather that it is the risk losses which create economic problems, and which give the risk its unfavorable connotation. Losses are abhored, but gains are delightful!

1/ Schickele, Rainer, "Socioeconomic Aspects of Risk and Uncertainty in Agriculture," Proceedings of Research Conference on Risk and Uncertainty in Agriculture, Great Plains Council Pub. No. 11, North Dakota State University, 1953, p. 15.

Insurance texts tend to consider risk as an adverse deviation of the actual occurrence from the expected. Probably this is because insurance is not concerned with risk gains. Magee presents the following definition:

> The uncertainty of the happening of an unfavorable contingency has been termed "risk." More simply, from the standpoint of insurance, risk is present when there is a chance of loss. 2/

Athearn also stresses the loss aspect of risk:

> As was mentioned in the preceding chapter, risk is the chance of loss. It is the chance that something unpleasant or undesirable will occur. The chance or possibility that your car may be stolen or your house destroyed by fire is a risk. Because there is merely a possibility of such losses and an individual cannot be sure whether they will or will not occur, the presence of risk is a source of uncertainty. Uncertainty is a state of mind which most people find unpleasant. 3/

Some authors do not make a point of distinguishing between risk and uncertainty; for instance, Lucas and Wherry combine the two terms, but again imply a risk loss rather than risk gain:

> Briefly, the term "risk" is used to denote uncertainty. In insurance, it may be termed the "event insured against" or "the chance of loss." 4/

In the last three definitions risk is described as a chance of loss, which implies a probability of loss. Schickele speaks of an evaluation of how badly a deviation from the expected event may affect a person's well-being. There is agreement that risk implies a probability of loss arising out of deviation from the expected occurrence--that the loss expectation is amenable to calculation. Thus, the most appropriate definition of risk and

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2/ Magee, John H., General Insurance, Richard D. Irwin, Inc., Homewood, Illinois, 1953, page 54.

3/ Athearn, James L., Risk and Insurance, Appleton-Century-Crofts, New York, 1962, page 45.

4/ Lucas, George G., and Wherry, Ralph H., Insurance Principles and Coverages, Rinehart & Co., Inc., New York, 1954, page 16.

uncertainty for the purposes of this dissertation is that by Knight, the "Dean" of Risk and Uncertainty:

> To preserve the distinction which has been drawn in the last chapter between the measurable uncertainty and an unmeasurable one we may use the term "risk" to designate the former and the term "uncertainty" for the latter. . . .
>
> The practical difference between the two categories, risk and uncertainty, is that in the former the distribution of the outcome in a group of instances is known (either through calculation a priori or from statistics of past experience), while in the case of uncertainty this is not true, the reason being in general that it is impossible to form a group of instances, because the situation dealt with is in a high degree unique. 5/

The important point in these definitions is that risk is measurable, a distinction which will be adhered to when the term is used in this study, except that sometimes the term "risk" will be used to denote the object to which the chance of loss is applied. Magee brings this use of the term into his definition of risk:

> The term is likewise used with reference to the object to which the uncertainty attaches. We speak of the building insured as a good risk, a poor risk, a protected risk, or a fireproof risk. 6/

The use of the term in this way is a matter of convenience, particularly since it is used universally in insurance literature to designate the insured object.

Measurement of Uncertainty

Using the definition that risk is a measurable uncertainty, a future event that is an uncertainty to an individual can be a risk to a group of similar individuals. A man knows that his house could burn down. He may know that according to statistical probability he would not expect it to burn within his lifetime. But it could burn down tomorrow. He is

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5/ Knight, Frank H., Risk, Uncertainty and Profit, Kelley & Millman, Inc., New York, 1957, page 233.

6/ Magee, op. cit., page 54.

faced with uncertainty. He cannot measure the uncertainty, because, for instance, he can in no way estimate how much reserve to lay aside each year to protect himself against the contingency. On the other hand, there is some size group of similar homeowners, with similar houses under similar conditions, such that it is possible to find some annual rate of deposit which would be sure within a given range of probability to accumulate sufficient funds to pay for any fire losses within the group during the year. This is the essence of insurance, which Knight refers to as the consolidation method of dealing with uncertainty:

> Following the order of the classification already given of methods of dealing with uncertainty, the first subject for discussion is the institutions or special phenomena arising from the tendency to deal with uncertainty by consolidation. The most obvious and best known of these devices is, of course, insurance, which has already been repeatedly used as an illustration of the principle of eliminating uncertainty by dealing with groups of cases instead of individual cases. 7/

Before proceeding to the discussion of the theory of insurance it is necessary to define what is meant by the measurability of uncertainty. It has been implied that a sufficient number of similar individuals in a group, or of similar objects subjected to uncertainty, provides a basis for measurability. But uncertainty involves the future, and there is no reason to expect that even extremely large groups will provide a basis for an expectation exactly the same as the actual event. In lieu of exact predictions, which are impossible in the real world, statistical measures based on probability provide the tools for measurement of risk, or chance of loss. According to Athearn, there are two methods of making estimates of probability: (1) Deductive reasoning whereby the characteristics of the object and perils are examined and through a process of logical reasoning, the chance of occurrence of all the possible events are estimated. An example is the process of deducing the occurrence of heads or tails in the toss of a coin by analyzing its physical characteristics. However,

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7/ Knight, op. cit., page 245.

most economic uncertainties are not amenable to a priori cataloging of characteristics, but must be handled by (2), the inductive method, whereby events of the past are observed and the assumption is made that the same will happen in the future if the same conditions prevail. The simplest example is figuring the probability of getting heads by the flip of a coin by flipping it several times and observing what proportion of the flips turn heads. 8/

A problem is injected at this point, the solution to which is vital to insurance understanding. In the case of the coin example of the inductive method, how can one be certain that enough observations have been made that he can be reasonably certain of the estimated probability of obtaining heads? "Enough observations" involves the Law of Large Numbers, and "reasonably certain" involves the tests of significance or reliability, each of which will be discussed in turn.

The Laws of Large Numbers are defined in various degrees of precision, depending upon the purpose for which the concept is used. For purposes of this discussion of insurance the simple definition of Athearn's is sufficient:

> The law, or principle, of large numbers may be stated as follows: The larger the number of trials, the more nearly actual experience will approximate the underlying probability. 9/

Thus, the Law says that, using the inductive method of estimating probability, the more observations made upon which to base the estimate, the more accurately can the estimate be made. However, the definition says nothing about how many observations are necessary so that the estimator can be reasonably certain of the accuracy of his estimate. Tintner's more sophisticated definition provides a clue to reliability:

> It is almost certain that the difference between the theoretical mean value (mathematical expectation) and the

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8/ Athearn, op. cit., pp. 52-53.

9/ Athearn, op. cit., page 53.

> empirical arithmetic mean of a number of random variables becomes as small as desired, if the number of random variables is sufficiently large. 10/

His definition implies that an allowable deviation be selected, and enough observations be taken so that the probable error of the estimate falls within the desirable deviation. The method is familiar to students of statistics: A reliability test is applied to the data such that the estimator can be, for instance, "95 percent confident" that the true outcome will be within a given range of the estimate. If he wants to be, say, 99 percent confident, the number of observations must be increased accordingly. The problem for the estimator then becomes that of selecting the confidence level he wishes to obtain.

Tintner's definition of the Law of Large Numbers refers to "random variables," a common term in sampling theory, which in turn is part of the inductive process of estimating probability. An adherence to sampling theory is basic to accurate probability estimating. Later in this chapter it will be brought out that perfection in probability estimating is impossible of achievement with respect to risk and insurance. However, it should be stressed at this point that the closer the approach to achievement of perfection, the more reliable the results.

Requirements of Good Sampling Procedure

Pfeffer says that the most difficult question for the actuary (the insurance-industry name for the estimator referred to above) to answer is whether or not ". . . inferences derived from the mathematical model (are) valid for the universe under study." 11/ In other words, if the actuary observes the effects of grouping of past events upon a sample of individuals how can he determine the validity of applying or inferring the results to a similar group in the future?

10/ Tintner, Gerhard, Mathematics and Statistics for Economists, Holt, Rinehart and Winston, Inc., New York, 1953, page 210.

11/ Pfeffer, Irving, Insurance and Economic Theory, Richard D. Irwin, Inc., Homewood, Illinois, 1956, page 60.

> The solution of this problem hinges upon meeting the requirements implicit in the formulae of sampling theory. Statistically, randomness and the existence of fixed limits to relative frequencies--there must be an underlying probability for the occurrence of the variate in the universe of data--are the only essentials for the applicability of the Laws of Large Numbers. In practice, however, these requirements must be stated more explicitly in order to determine the extent to which they are met. 12/

The first requirement is a clearly defined collective--the statistical universe whose characteristics are to be inferred from the sample. 13/ For the actuary this means that there must be a high degree of homogeneity between the observed sample and the universe to which the derived inference is to be applied. If known changes have occurred between the sample and the future population, and if they are not amenable to a correction factor, then this first requirement is not met. The crop insurance actuary's problem with this requirement is that he must be careful that his sample of potential insureds is representative of the actual insureds. He must allow for changes that have occurred in technology, for instance, between his sample or observed potential insureds and the actual insureds. He must be alert to changes that have occurred in control over perils between the sample and the population to which inferences will be applied.

The second requirement of the sampling method is randomness, referred to in Tintner's definition above. Pfeffer lists two requirements for randomness which most clearly defines the term: (1) Homogeneity of units within the group or population:

> Exposure units are said to be homogeneous when their probabilities of loss from the occurrence of a specific peril are equal. . .
>
> Homogeneity can only be maintained in the absence of factors which tend to disturb the underlying probability of the variate in a random sample. The existence of a "moral hazard," which causes the insured to alter the expected loss

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12/ Ibid., page 60.

13/ Ibid., page 60.

> experience either by the commission of arson, suicide, or some other crime against an insured life or property; and the presence of a "moral hazard" whereby insureds grow careless because of the possession of insurance, both destroy the homogeneity of the sample. Homogeneity thus requires that the event insured against be "accidental" in the sense that the occurrence is beyond the control of the insured. 14/

Here the concept of adverse selection of risks is described. It will be discussed more extensively later in this dissertation. It is apparent that the risk units must not only be homogeneous, but also the perils must not change between the sample and the future group. For instance, the estimate of risk of crop loss may include a substantial grasshopper peril, based on past loss history. However, it is well known that grasshopper infestation can now be effectively controlled by chemicals.

(2) The events must be statistically independent, meaning that "the occurrence of any one of them does not affect the occurrence of the others." 15/ Here again is a requirement that is rarely achieved in reality, but which should be carefully noted and properly accounted for to the greatest possible degree. Statistical independence forms the basis of a considerable portion of this dissertation in the sections on perils and merit rating.

The third requirement of the sampling method is mass--a sufficiency of exposure units in the sample. This requirement, too, is often unattainable, yet is the goal of the actuary who follows the rule that the larger the sample, the better will be his estimate. Later this requirement will be discussed in connection with the problem of participation in crop insurance, spread of risk, and merit rating.

Summary--Risk and Uncertainty

Uncertainty arises out of the failure of future events to occur according to expectation. Specialists in the field of risk and uncertainty usually reserve the risk term for the measurable chance of gain or loss

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14/ Ibid., page 62.

15/ Ibid., page 63.

arising out of uncertainty. Risk usually is identified with loss rather than with gain, particularly in the field of insurance because insurance is concerned only with the problem of risk loss. Also in the field of insurance the term risk is used to denote the object to which the chance of loss is applied--the object insured, such as house, person, or crop.

Chance of loss implies an estimate of probability. In insurance the inductive method of estimating probability is used, which involves the observation of samples of past events or risks, including the accompanying perils, and from the sampling process infers loss probability for a population similar to the sample.

The inductive method requires correct sampling theory for accuracy in estimating probabilities. The requirements are: (1) A clearly defined collective--a homogeneity between the sample and the population about which an inference is made from the sample; (2) Randomness--a homogeneity of units within the population, and a statistical independence between events; (3) Mass--a sufficiency of exposure units in the sample, which is also a requirement of the Law of Large Numbers and a basic consideration in tests of reliability.

The point is often stressed that the ideal requirements of sampling theory are not attainable "in the field," but that the closer they are approached, the more accurate will be the results achieved. Thus meeting the requirements becomes the goal of the insurance actuary, although it (the goal) is seldom perfectly achieved.

Theory of Insurance

Definition

There are many definitions of insurance, depending upon whether the problem is related to the insured, to the insurer, to legal matters, to an actuary striving for perfection, to a private corporation, or to a public official committed to the job of executing a program legislated by Congress.

The simplest and most appropriate definition from the standpoint of the insured is that insurance is a device whereby an individual can

substitute a certainty for an uncertainty. In the case of crop insurance, a farmer can use the device of Federal crop insurance to exchange part of his uncertainty of crop yield for a certain crop insurance premium. Magee begins his book with this definition:

> The function of insurance is to provide certainty. To effect this end, insurance seeks to reduce the uncertain consequences of a known peril, so that the cost of losses as they affect individuals will be certain, or at least relatively certain. 16/

This suffices as the functional definition of insurance. A great deal of time and space could be used to expound the many other definitions of insurance which would contribute very little to the idea of its function as simply stated above. However, for purposes of this dissertation and in order to be more precise when speaking of "insurance," the "necessary and sufficient criteria of insurance" must be established. Pfeffer combines these criteria or conditions into what he calls his generic definition:

> Insurance is a device for the reduction of the uncertainty of one party, called the insured, through the transfer of particular risks to another party, called the insurer, who offers a restoration, at least in part, of economic losses suffered by the insured. 17/

Thus the necessary and sufficient criteria for insurance as the term will henceforward be used are: (1) It is a device, something contrived to accomplish a specific purpose. A deficiency in his definition is that he does not stress the grouping aspect of insurance, which is implied in the term risk, and is necessary to future discussion of insurance. That is, insurance is an institution--a device whereby there is a grouping of individuals, or risks, for the purpose of accomplishing certain ends, namely decreasing uncertainty to the individual members. (2) By means of this institution or device, risks are transferred to another party. This party may be a person or a legal entity such as partnership, corporation, or

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16/ Magee, op. cit., page 3.

17/ Pfeffer, op. cit., page 53.

association, which binds itself by agreement to a given degree of restoration of given economic losses suffered by the participating individuals. (3) The purpose of insurance is implied in the above two criteria--to reduce the uncertainty of the participating individuals, the insureds.

Pfeffer tends to avoid the use of the term "institution" in his final connotation of insurance; other authors consider it as a necessary part of an insurance definition. This author prefers to stress the inclusion of "institution" in the definition because the collective aspect is important in distinguishing insurance from many other devices for reducing uncertainty. Examples are so-called self-insurance schemes such as one individual assuming the risk of another, without grouping several risks--a father pledging some of his resources to back his son's venture. Another example is an individual storing grain in lieu of taking crop insurance. Athearn incorporates the institutional concept in his definition:

> The essence of the insurance scheme is that it is a social device, that it involves the accumulation of funds, that it involves a group of risks, and that each person or firm who becomes a member of the group transfers his risk to the whole group. 18/

A "social device" is an institution. This author is now taking the liberty of contriving his own generic definition for purposes of framing the term for all future reference in this dissertation: Insurance is an institution devised for the purpose of reducing the uncertainty of each party (called the insured) participating in the institution through the transfer of particular risks to another party (called the insurer). The transfer is accomplished through an accumulation of funds paid by the insureds to the insurer, from which funds the insurer agrees to restore a given part of economic losses suffered by an insured resulting from given uncertainties (called perils).

Insurance provides the insured with the means of substituting certainty for uncertainty. The insurance institution faces the problem of

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18/ Athearn, op. cit., page 51.

combining risks in such a way, and charging the insureds such an amount that premiums collected equal the probable losses paid plus any additional costs involved, such as administrative, adjusting and sales costs. The probable loss is a function of the perils covered, the probabilities of their occurrence and extent of losses caused thereby.

The Nature of Insurance

The ideal insurance situation is one in which the risks covered meet the accepted requirements of insurability. Greene prefaced his list with the reservation:

> These requirements, as presented below, are not necessarily complete. . . . The requisites listed are intended to be suggestive of the type of underwriting standards usually looked upon as basic to the acceptance or rejection of risks as submitted to the insurer. These requirements should not be considered absolute, as iron rules, but rather as guides. In practice, for example, it is not at all uncommon for an insurer to accept a risk even though some of the following requirements are not met, providing the premium to be earned is great enough to compensate the insurer for his risk. 19/

Likewise, the following list of requisites for ideal insurability, compiled from Athearn and Greene, are to be used as guides in evaluating and analyzing the subject insurance problem: 20/

1. The risk should be measurable within some predetermined level of reliability; that is, there must be homogeneity among the insured units, the loss-causing perils covered must occur randomly and independently, and there must be a large number of exposure units (These are the requirements of sampling theory). This requisite is vital to the insurer, who must be able to predict his probable loss cost to which he has obligated himself by the insurance agreement, and to calculate a charge or premium for the insured that will

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19/ Greene, Mark R., Risk and Insurance, South-Western Pub. Co., Dallas, 1962, page 47.

20/ Athearn, op. cit., pp. 54-56 and Greene, op. cit., pp. 46-50.

not only cover the expected loss cost, but must include the insurer's expenses of operation and normal profit over the actuarial period. (The actuarial period is the time span over which the insurer predicts his loss cost. In most insurance, the period is one year, geared to the normal annual premium. However, it is very important to note that the actuarial period must be much longer in an insurance program, such as crop insurance, where perils do not occur randomly within a year, but rather over several years.)

2. Losses must be accidental. This requirement is implied in the requirement for randomness, since perils under the control of the insured could not be expected to be random, nor completely independent of other perils. Further, a peril that can be influenced by the insured, or otherwise not accidental, is no longer uncertain. This requirement is important in avoiding the "moral hazard"--the chance of an insured using insurance for gains over and above his expected losses from uncertainty. The failure to meet this requirement can have a very adverse effect on fulfilling the requirement for large numbers of insured units:

> Because of the requirement that the loss be accidental, insurers normally exclude in all policies any loss caused intentionally by the insured. If the insured knew that the insurer would pay such losses, a moral hazard would be introduced, and there would be a tendency for losses and premiums to rise. If premiums become exceedingly high, so few would purchase insurance that the insurer would no longer have sufficiently large numbers of exposure units to be able to obtain a reliable estimate of future loss. Thus, the first requirement of an insurable risk would not be met. 21/

3. Loss must be determinable and measurable. In addition to a risk being capable of statistical measurability, the loss involved must

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21/ Ibid., page 48.

be identifiable and capable of being evaluated. One example of the problem involved when this requirement is not met is in accident and health insurance: If the policy provides for payments in the event of "complete disability" the question arises as to exactly what constitutes complete disability, and just exactly when does it begin? Another example is in the case of bodily injury liability: What is the exact loss caused by the injury of a person, to himself and to his family? Greene points out that the evaluation procedures and determination procedures must be set up by the insurer before he assumes the burden of risk. 22/

4. The loss must not be subject to catastrophic peril. A catastrophe can be defined in different ways, but in general it means an extreme deviation from the expected average that was not comtemplated. An example is a peril that affects simultaneously the whole group of insureds, such as a storm that devastates an entire geographic area. Most types of insurance cannot avoid the catastrophe peril, but make allowances for it by wide geographic dispersion of risk, by wider dispersion of the actuarial period over time, by weighting the premium to accumulate a special reserve over a longer period, or by reinsurance, which in effect sets up a new insurance institution. Hail insurance is an example which uses several of these methods of meeting the incidence of catastrophe risk. Most insurers do specifically exclude certain catastrophes where the potential loss is essentially limitless or for which adequate reserves would not be feasible. The best example is the clause excluding war and insurrection in every domestic property-damage policy.
5. The potential loss must warrant protection. This means that the potential loss from perils covered must be significant to the individual insured:

22/ Ibid., page 49.

> Regardless of how economically the scheme may be operated, insurance for risks that are not significant for prospective insureds will not function. No one wants it. The possible loss must be significant to the person who faces the risk or he will not bother insuring it. If, for example, all the people who own automobiles were millionaires, it is doubtful that much automobile physical damage insurance would be written. Such losses would not be significant to the automobile owners. 23/

Much can be said about types of insurance that include coverage for insignificant perils--risks which most insureds can absorb out of current income or savings. However, most of these risks are included with more vital coverages. Greene points out that from the standpoint of the insured:

> A basic principle of insurance buying, however, is that the most economical use of insurance premiums is first against the serious loss and then against the less serious losses, and not vice versa. 24/

6. The probability of loss must not be too high, or, as Athearn puts it, the insured risk must be economically feasible. The higher the probability of loss, the more certain it becomes, and the higher will be the ratio between the premium and the possible loss and the less attractive the insurance appears to the insured:

> The contract becomes one of "trading dollars" with the insurer, but on an unfavorable basis to the insureds, since the insurer must collect more money than he pays out to the policyholders in order to cover the cost of doing business. 25/

This last requirement is the one with which crop insurance comes into conflict. Writing it is not economically feasible in certain especially high-risk areas. Flood insurance is not economically feasible because the

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23/ Athearn, op. cit., page 56.

24/ Greene, op. cit., page 50.

25/ Ibid., page 50.

high probability of loss requires a premium too high for those who are interested in it--those located where floods can occur.

The Nature of Insurance--Imperfections

In practice, the different types of insurance rarely if ever meet all the accepted requirements of insurability listed in the preceding section. Rarely are two situations, people, objects, or perils exactly alike. Definitions of classifications or groupings can seldom be perfectly inclusive and exclusive. This is why, as Greene said, the requisites for insurability are looked upon as guides, not as absolute requirements. 26/ The problems in insurance programs are found in the deviations from these insurability requisites. The place to look for solutions to the problems is in the deviations and how they are handled by the insurance institutions.

Most insurance fails to meet the measurability-of-risk requirement, or the requirements necessary for accurate predictability, especially within the premium time period. For instance, the normal time period covered by a premium is one year, except in life insurance. However, the time period required for an accurate prediction of a certain type loss may be five or more years. Where this is the case, the insurance institution must in some way predict the probable annual deviation from their long-term prediction and make allowances accordingly:

> Experience has demonstated that in a particular group of risks for a given period the losses will not of necessity correspond exactly to the average loss as indicated by statistical evidence. Losses vary from year to year, one way or the other, from the average figure. The insurer who is interested in eliminating uncertainty must recognize this element of variation and make provision for meeting it. Accordingly, he is interested in knowing not only the probable losses for a given year but also the probability of a deviation from the predictable average. 27/

26/ Greene, vid., page 19.

27/ Magee, op. cit., page 74.

An insurance institution must therefore build reserves in premium-surplus years to balance deficits in premium-deficiency years. Some companies, rather than risk their own financial position to meet this situation, use the reinsurance method to protect themselves against the uncertainty of deviations from the long-term predictions. By reinsurance, they combine their risks with those of other companies, converting their own individual uncertainty to a risk for the larger group, paying the reinsurance institution a premium for the risk assumption. Institutions which do not recognize or choose to ignore the annual deviations from the long-term predictions are risking financial difficulties or having to adjust premiums every year, either of which leads to inefficiency in operation.

It is important to note that all-risk crop insurance covers perils that can strike an area as large as the entire United States in a given year. An example is the drouth of the 1930's. This situation precludes the use of a reinsurance plan to convert uncertainties for a smaller company to a risk for a group. The only recourse in this case is to huge resources which are available only to the Federal government.

All insurance companies prefer to limit themselves to coverage of only the accidental and unintentional losses--to eliminate the moral hazard. However, it is impossible to "ride herd" on insureds, and also to accurately discern the moral hazard. For this reason, sound insurance institutions are obliged to do two things: (1) Incur expense to "underwrite"--that is, expend effort to eliminate as much of the moral hazard as possible; and (2) make a charge for an estimate of moral hazards that cannot be eliminated. In the section on merit rating it will be shown how a premium can be weighted to allow for the moral hazard, and how experience credits can be used to discourage voluntary loss-causing acts, and encourage risk-improvement efforts, instead.

The most difficult problem in disability, workmen's compensation, and liability insurance is the failure to fully meet the requirement of determinability:

> It is a real problem to insurers, however, to be able even to recognize certain losses, let alone to measure them. For example, in health insurance, the insurer may agree to pay the insured a monthly income if "he should become so totally disabled as to be unable to perform the duties of his occupation." The question arises, however, as to who will determine whether or not the insured meets this condition. . .
>
> Even if it is clear that a loss has occurred, it may not be so easy to measure it. For example, what is the loss from "pain and suffering," or of an auto accident victim? Often only the jury can decide. 28/

Here again is a deviation from the ideal insurance requirements which is a source of insurance-management problems. Not only must annual deviations from the long-term average be recognized, but also the premium must allow for the non-random effects of changing laws, variations between jury attitudes, effects of new court interpretations, and other influences not amenable to statistical prediction.

One can scarcely conceive of a risk that is not subject to some catastrophe peril. Here it must be remembered that the definition of a catastrophe depends upon the situation of the insurance institution. To a small insurance company, concentrating most of its hail insurance in one state, a severe hailstorm would be a catastrophe against which it could probably not build sufficient reserves. However, if it traded risks with other companies over several states in different agricultural regions, this same storm would not be a catastrophe. This is the typical method used by insurance companies to convert what might be a catastrophe to the individual company into a measurable risk for a group of companies. Sometimes there are catastrophes of a type that cannot be accepted by insurance institutions within a feasible premium framework. An example is the war peril. It is usually excluded from coverage altogether. Another example is damage from nuclear activity, which is assumed to a certain extent by the Federal government. Some catastrophe perils are accepted by special risk bearers, such as the Lloyds Group, who are in the business of

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28/ Greene, op. cit., page 49.

combining so-called catastrophe perils, and in some cases assuming the uncertainty of others with the hope of gaining a profit over a period of years.

From the standpoint of the insurance institutions it is not important whether a risk is worth insuring, as long as buyers are willing to pay the required premium. Insurance sales efforts, and lack of understanding, often cause consumers to overestimate the actuarial value of small coverages. However, there are other values that the consumer attributes to insurance and for which he is willing to pay. In health and accident insurance the cost of paying small doctor bills through insurance is much higher than if paid directly. Yet many insureds apparently prefer the expensive "forced saving" feature of insurance to voluntary saving for health contingencies. In auto insurance apparently many people prefer the convenience of an insurance company taking care of their losses, rather than taking care of small losses themselves at a lower cost. Thus, many potential losses are covered under insurance policies, whether or not they theoretically "warrant protection."

The economic feasibility of a risk is difficult to determine, and varies considerably from one type of insurance to another. It would appear that the greater the probability of loss, the more likely would the individual want to insure. However, there appears to be a point (and it varies with different types of insurance) where the ratio between premium and the insured's potential loss is higher than he is willing to go. Insurance companies in most cases are forced to "feel their way" in attempting to determine whether potential insureds will accept the premium necessary to safely insure a certain peril in a particular situation. The author noted during his experience in selling insurance that many insureds would, for instance, pay as much as $50 per year for collision insurance on a car worth $500, and turn down the opportunity to protect themselves more adequately by raising their liability coverage from $10,000 to $25,000 for a premium increase of only $5 per year. It is not now feasible to write flood insurance on dwellings, but if those who are interested would be

willing to pay the necessary premium, it could probably be written. On the other hand, businesses in some risky categories are willing to pay rates as high as 10 percent of the value insured. Naturally when the probability of loss is high more effort will be expended, and more cost will be incurred in decreasing the probability of loss. This is why investments are made in sprinkler systems in large business establishments, and why time and money is expended on safety programs.

Some insurance programs deviate so far from the requirements of insurability that it is questionable whether they are in fact insurance. Reede, expressing the actuarial view in 1936 when writing on unemployment insurance, argued that there were reasons why unemployment should not be considered an insurable risk. In fact he indicated opposition to using the term in connection with any form of social insurance:

> The increasing use of the term "reserves," (or "compensation," or "benefits") rather than "insurance," when referring to unemployment insurance, reflects a prevalent view that it is unwise actuarily to treat the problem of unemployment. It has long been held that the term "insurance" should not be used in connection with any form of social insurance. . . . The objections to the use of the term seem strongest in regard to unemployment insurance. The opposition seems to come from two sources. On the one hand, many business leaders, economists and actuaries doubt that unemployment is an insurable risk. On the other hand, many students of labor and other social problems fear that many features of an unemployment insurance program will not be included unless there is escape from the term "insurance." 29/

Reede gives the following reasons why unemployment insurance should not be considered "insurance:"

1. Inadequacy of data covering a long period of time.
2. Lack of predictability: The past is inaccurate indication of future; imperfect knowledge of causal factors; occurrences are

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29/ Reede, Arthur Hallam, The Actuarial Aspect of Unemployment Insurance: British Experience, Penn. State College Studies, Vol. 1, No. 1, 1936 page 2.

not independent over time, and also not even independent of the insurance.

3. Difficulty involved in classifying of risks because of problems in defining homogeneous groups.
4. The insurance itself provides an incentive for stability, so that the exposure to risk is not random. 30/

A social risk-assumption program can qualify as insurance under this definition as long as it involves the grouping of risks, the individual risks contribute to the accumulation of funds, and restoration of losses are made from this fund. In Chapter VII under the Judgment Rating section it will be pointed out that some phases of fire insurance, one of the oldest accepted types of insurance, are completely devoid of statistical prediction, but sill qualify as insurance.

Summary--Theory of Insurance

Insurance is an institution devised for the purposes of reducing the uncertainty of each party (called the insured) participating in the institution, through the transfer of particular risks to another party or group (called the insurer). The transfer is accomplished through an accumulation of funds paid by the insureds to the insurer, from which funds the insurer agrees to restore a given part of economic losses suffered by an insured resulting from given uncertainties (called perils). From the standpoint of the individual confronted with economic loss due to uncertainty, insurance provides him with the means by which he can substitute certainty for uncertainty.

The soundness of an insurance program depends upon the degree to which the insured situation meets the accepted requirements for insurability: (1) Statistical predictability, which requires randomness and independence of occurrence of events; (2) losses accidental--no moral hazard; (3) determinability and measurability of losses; (4) losses not

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30/ Ibid., page 2.

subject to catastrophe perils; (5) losses are significant to the potential insureds; and (6) relatively low probability of loss.

Practically all types of insurance written fails to meet some or all of these insurability requisites to some degree, in one way or another. Most of the insurance problems arise out of the deviations from the ideal situation. The requirements are a guide, and solutions to the problems are found in methods used to allow for the deviations. Newer insurance programs will find many parallels in the older, more mature institutions.

Insurance Compared with Other Methods for Meeting Uncertainty

Insurance involves costs of administration, including normal profits to the business firm. In addition, since few if any risks meet all the requirements of insurability, the insurance premiums must also include a payment for the assumption of some uncertainties along with the risks. Where this portion of the premium (which arises from factors other than the pure risk itself) is relatively large, there is a strong incentive for individuals and firms to use other methods to meet uncertainty. (It should again be emphasized at this point that the uncertainties under question are those that can be converted to insurable risks--they do not include such uncertainties as those due to management ability, market changes, technology, government policy, or changing tastes and customs.) Any classification of other-than-insurance methods is beset by the problem of overlapping, the following being no exception:

Examples of Other Methods

Loss Prevention.--The commonest method, and socially most desirable, is removing or reducing the uncertainty by reducing or removing the loss peril. Examples of such methods are the installation of sprinkler systems (this adds the sprinkler-leakage peril, which is not as severe as the fire peril which is reduced by the installation), building of fire-resistant structures, safety installations, physical checkups, better farming methods, information and education. All of these methods of loss prevention involve added costs to the firm, which must weigh the added costs against the cost

of insurance. Loss prevention is combined with insurance as a method of reducing the insurance premiums. In some cases insurance companies employ loss-prevention methods to reduce a risk to a level which makes insurance economically feasible. Loss prevention will be discussed further in Chapter VII, under merit rating.

Expansion of the Firm--Diffusion, Diversification, and Dispersion.--Individual firms can, by expansion, accomplish the conversion of uncertainties into measurable risks, which is no different from insurance except that perils are grouped within the firm, rather than combined with those of other firms under an institutional arrangement outside the firm. This method is often called "self-insurance," but does not meet the usually accepted definition of insurance (nor the definition accepted for this study), particularly that insurance is an institution apart from the firm, set up for a special purpose.

By expansion a firm is able to increase its volume of business activities such that any one peril may not be relatively important. Suppose, for example, that a firm has one plant, and that its fire risk is the loss of this plant in 100 years. If it lost the plant within the first five years of operation, the uninsured loss would presumably put the firm out of business. On the other hand, suppose the firm had 100 such plants, dispersed geographically. It could expect one plant to be destroyed each year, and building a reserve for such contingency is not out of the question. Further, the firm would not necessarily be out of production while the plant was being restored, but could possibly add the output to the other 99 plants. This is the "diffusion" process of meeting uncertainty by expansion of the firm--as a firm becomes larger, a given loss peril becomes relatively less critical.

Diversification of enterprises is possible through expansion of the firm. By expansion into enterprises which are not subject to the same perils, a firm is reducing the relative risk from any one peril. Farming presents one of the best examples of this method of meeting uncertainty. It is often argued that a diversified farm does not need crop insurance

as badly as a straight crop farm, the idea being that the same perils that cause crop losses are not the same ones that cause livestock losses. Some crops are not susceptible to the same perils as others.

However, the big disadvantage of diversification, especially if not accomplished along with expansion, is that it requires a sacrifice of some of the advantages of specialization. Here again, the firm must weigh the sacrifices against the gains. If a firm can be expanded to the point where each enterprise is a completely specialized unit in itself, then it avoids the sacrificing of specialization advantages.

Especially where weather perils are critical, as in farming, dispersion of the firm is an important method for meeting uncertainty. For example hail is known to occur over a relatively small area in each storm. One wheat farm in Montana with which the author is acquainted has had a maximum annual total hail loss in over 50 years of less than 50 percent, but has had nearly 100 percent loss on part of the farm at least ten times. The farm has a maximum dispersion of two miles in one direction and one and one-half miles in the other.

Reserves.--An individual or firm can accumulate reserves against the risk of loss. Three problems are involved here: (1) Having sufficient time to accumulate reserves to meet the first critical loss; (2) protecting against the contingency of being the concern that has more than the expected losses from uncertainties; and (3) the management of the reserves--how much, maintaining liquidity, and profitable investment. This method, of course, overlaps in many ways the expansion method. The larger the firm, the more accurately can the required size of the reserves be determined, the less (relatively) reserves are needed, and the more the firm can specialize in the management of the reserves. Farmers have often maintained stores of crops for meeting uncertainty of crop loss. However, storage of commodities has the disadvantage of possible loss through deterioration, accidental loss by fire and other perils, and unfavorable changes in price. Storage also involves costs. Reserves in small firms are subject to dissipation--being used for other contingencies--or not

being sufficiently liquid when needed, principally because of management deficiency.

Basic Advantages of Methods Other Than Insurance for Meeting Uncertainty

The concern here will be with the economic advantages of using methods other than insurance for meeting uncertainty. If there is a monetary gain in using other methods, what are the basic sources of the gain? The sources must be found outside of pure risk, or in differences between the magnitude of the risk as faced by the insurance institution as compared with the risk as faced by the firm itself. In most cases, and in farming especially, risks are not perfectly random, and the producer does have some opportunity to affect the amount of risk. If he chooses some method other than insurance for meeting uncertainty, the incentive to prevent losses is greater than if he is paying a premium to an outside institution. This is particularly true if his risk of loss is lower than the average upon which the premium is based, and such difference is not compensated by a premium reduction. If a firm is assuming its own risks, all the net gains from loss prevention and avoiding claim-settlement costs accrue to itself. Also, there is nothing gained by creating a moral hazard within a firm. These factors are all elements of cost that can seldom be completely avoided in insurance.

Some firms, which are of sufficient size that they can afford specialized management and sufficient resources to ride out a financial storm, can meet their own uncertainty situation at less cost than an insurance company because of better knowledge of their business. Some firms are faced with risks which are so far below the average that the cost of their own loss-protection methods is appreciably below that of insurance. This is a situation that should be carefully considered with respect to large farming units.

It is sometimes argued that the insurance-sales costs are an appreciable portion of an insurance premium and can be saved when a firm uses other methods of meeting uncertainty. On the other hand, insurance companies would argue that sales efforts are responsible for efficiency in

the operation of insurance companies, and consequently are not an added cost. To the extent that this is not so, sales costs can be a saving to a large concern that uses other methods to treat its own risks.

If we accept Knight's thesis that "pure profits" arise out of uncertainty, then the firm which can well-manage its own risk assumption is in a position to keep these profits to itself--an addition to its total volume of business and profits. 31/

Basic Economic Advantages of Insurance--To the Firm

The circumstantial evidence (high volume of sales) points to the fact that there are economic advantages of insurance to individuals and firms. These advantages, if there be such, are especially important to this study if it is to contribute to the improvement of the Federal crop insurance program. The economic advantages must be isolated, analyzed, and exploited. The magnitude of the total volume of insurance sales in the United States indicates acceptance of insurance and the apparent awareness of advantages. Table I shows that the total of insurance purchases in 1959 was equivalent to about one-eighth of the total national income of $400 billion. Private insurance alone equalled about one-twelfth of the national income. But particularly important is the fact that insurance buyers were willing to pay private insurers twice as much premium as they received in benefit payments! Even allowing for the fact that this was a period of growth, particularly in life insurance, and that benefits would accordingly tend to lag behind premiums, it is notable that insureds would be willing to pay such a high margin above actual risk. According to Best's, in 1961 the 100 largest stock and mutual fire and casualty companies earned almost $12 billion in premiums; indemnities and

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31/ Knight, op. cit., page 48. It should be noted here that "profit" was previously defined by Knight: "It will be perceived that the word 'profit' is here used in the sense of 'pure profit', a distributive share different from the returns to the productive services of land, labor, and capital." (page 18)

TABLE I. INSURANCE ACTIVITY IN THE UNITED STATES, 1959, MEASURED BY ASSETS, PREMIUMS, AND BENEFIT PAYMENTS.*

Sector of Activity	Assets	Premiums	Benefit Payments
Private insurance activities			
Private insurance companies	$142,251,876,057	$30,706,360,406	$15,192,950,061
Private noninsured pension funds[a/]	23,800,000,000	3,100,000,000	1,000,000,000
Total private	$166,051,876,057	$33,806,360,406	$16,192,950,061
State government insurance activities			
Compulsory temporary disability funds	255,053,700	200,478,000	164,375,000
Hail insurance funds	2,888,200	2,072,719	1,554,756
Life insurance funds	2,177,311	193,410	89,301
Retirement funds (state and local)[a/]	9,249,000,000	1,755,000,000	603,000,000
Unemployment insurance funds	6,892,173,000	1,955,666,000	2,279,017,000
Workmen's compensation funds	1,229,673,615	339,194,666	263,730,779
Total state	$ 17,630,965,826	$ 4,252,604,795	$ 3,311,766,836
Federal government insurance activities			
Civil Service retirement & disability	9,212,841,693	1,515,852,193	791,615,469
Federal crop insurance	48,700,448	18,473,807	14,130,937
Federal Deposit Insurance Corporation	2,089,800,000	78,400,000	500,000
Federal Housing Administration	1,087,188,587	165,639,263	84,063,086
Federal Savings & Loan Insurance Corp.	301,541,000	32,948,845	None [b/]
Life Insurance (Veterans Administration)	7,389,510,020	541,445,722	457,644,116
Old-Age, Survivors, and Disability Ins.	23,207,620,512	8,460,000,000	9,388,230,682
Railroad Retirement Board	3,862,210,915	629,216,717	1,028,900,000
Total federal	$ 47,199,413,175	$11,441,976,547	$11,765,084,290
Total government	$ 64,830,379,001	$15,694,581,342	$15,076,851,126
Total private and government	$230,882,255,058	$49,500,941,748	$31,269,801,187

* Source: Athearn, James L., Risk and Insurance, Appleton-Century-Crofts, New York, 1962, Table I, p. 10.

a/ 1958 figures. "Noninsured" means not insured by a private insurance company.

b/ Losses have averaged 1.5% of premium for 24 years.

adjustment costs amounted to 60 percent to 70 percent of the premiums earned. 32/

The most obvious reason why individuals and firms are willing to pay a relatively large margin for the transfer of risk is that they are in no position to take advantage of the other methods of meeting uncertainty. Usually size is the limiting factor; they cannot group risks, diversify, or disperse their risks. Though there is a wide margin of cost above the pure risk of loss, these firms and individuals find they can save no money by using other methods.

Insurance is a specialized business, as are most other modern businesses. As such, it attracts the skills and experience that is necessary to calculate risks efficiently, allow for inherent uncertainties, and manage reserves. Even large companies would hesitate to build the organization that is necessary to handle risk as efficiently as a well-organized and competitive insurance company. They prefer to use their skills in furthering their own business, rather than divert or expand into an unrelated field, such as insurance.

Even though a firm is large enough that it can take advantage of insurance techniques, this does not necessarily mean that it can provide for its own risks as efficiently as an insurance institution. For example, suppose that a firm is composed of 100 plants. It is conceivable that it could calculate its fire and liability risks within some degree of reliability, and set up an allowance for reserves to meet the risk. However, it must also make an allowance for uncertainties within its framework of risk calculation. Logically, an insurer covering 100 such companies is in a position to calculate risk more accurately (the Law of Large Numbers), and require less allowance for uncertainties as to its risk calculations, changes outside the firm, and unknown perils.

32/ Best, Alfred M. Company, Inc., Best's Insurance Guide, Alfred M. Best Co. Inc., New York, 1962, pp. 76B-79B.

Services to insureds have been developed over the years, probably as a result of: (1) Sales competition and (2) an attempt to make risks insurable. It is hardly conceivable that many of these services would be as available and as effective under methods for meeting uncertainty other than through the competitive insurance industry. For example, risk program planning is one of the common services which is an important tool of insurance sales competition. In smaller companies this is a responsibility that is awarded to one of the managers who is probably much better trained for the principal business of the firm. A trained insurance company planner can be given the responsibility, and release the manager's time for work for which he is specially trained.

Another example of service is that provided in boiler insurance. Engineering and inspection was a necessary part of making boiler risks insurable, principally because boiler accidents were largely a function of management. It was necessary that this non-random peril be eliminated as completely as possible. Actually this service eventually resulted in relatively low rates. In addition, the trained boiler inspectors often were able to provide firms with cost-saving and efficiency-gaining advice with respect to installations and changes in boilers and machinery.

Insurance is an important tool in the availability of credit. The insurance policy is recognized evidence of loss protection. Few, if any, other methods for meeting uncertainty provide as strong evidence as the insurance contract. Many smaller firms are required by lending institutions to file evidence of insurance when they obtain credit. Particularly is this true in farming.

Summary: Insurance Compared with Other Methods for Meeting Uncertainty

The purpose of this section is to provide a background for the principal objective in this dissertation--to find ways in which the crop insurance program can be improved. The FCIC is in competition with methods for meeting uncertainty other than insurance. Three major categories of methods are: (1) Loss prevention; (2) expansion of the individual or firm's operations to the point where loss perils may be converted

from uncertainties to measurable risks for the firm; also expansion tends to reduce the maximum potential loss to the firm from any one peril; (3) the accumulation of reserves.

The evidence indicates that the cost of risk assumption through insurance amounts to as much as 30 to 70 percent of the premium earned by fire and casualty companies. This cost includes costs of administration and services, including sale costs, engineering, inspection, loss prevention and planning. In spite of striving for accuracy in prediction of losses, there remains the element of uncertainty, the cost of which is also included in premiums. The choice between buying insurance or meeting uncertainty by some other method is essentially no different from other economic choices: The choice will favor the method which will give the highest ratio between the marginal net gain and marginal net cost of the alternative methods. The difficult process is to determine correctly all costs and all gains, many of which are subjective and not amenable to measurement.

All-Risk Crop Insurance Compared With Other Types of Insurance

If all-risk crop insurance, in particular the Federal crop insurance program, is compared with more mature types of insurance, solutions to crop insurance problems might be found where there are similarities in organization, characteristics of insurability, perils covered, characteristics of the insureds, or wherever else the problems appear to be centered.

Federal Crop Insurance--A Public Institution

As a government institution Federal crop insurance enjoys a potentially unlimited source of resources against the uncertainty of a catastrophic loss, which is not available to private companies unless underwritten by the government. This situation is similar to other government insurance corporations, such as the Federal Deposit Insurance Corporation (FDIC), Federal Savings and Loan Insurance Corporation, Veterans Administration, the Investment Guaranties Division of the International

Cooperation Administration (foreign-investment insurance), and the Federal Housing Administration (loan insurance). "Unlimited" resources makes it possible for the Federal Crop Insurance Corporation to carry on experiments that are not economically feasible for private concerns. This is the basic reason why, after several failures of private companies to write all-risk crop insurance successfully (see Chapter III), it appeared that such insurance could be written only by the Federal government, at least during development stages.

Also related to the "unlimited" resources is the advantage a Federal institution has in the time over which it can extend and evaluate its loss experience. This does not mean the Federal government will always sanction consecutive years of net underwriting losses, but annual loss experience is not as pressing upon the government as it is upon a board of directors of a private company.

On the other hand there are at least two problems inherent in a public institution: Its operations are subject to public obligation and to political influence. These factors are sometimes in conflict with sound managment, as will be discussed in the next chapters.

Most of the other insurance institutions of the Federal government are completely compulsory (Social Security) or are in effect compulsory. The national banks are required to carry FDIC coverage, which, in effect, compels all banks to protect their depositors. One cannot obtain a FHA loan without obligating himself to pay for the loan insurance. However, Federal crop insurance is completely voluntary, not even required for compliance with farm programs, nor required by quasi-public corporations, such as Federal Land Banks or Production Credit Associations. Neither is it required by the Farmers Home Administration. As a public institution, the non-compulsory characteristic of the Federal crop insurance program is an important indication of how Congress (the public) views the FCIC's problems.

Competition

Insurance management seeks high sales volume. A basic reason is that requirements for insurability include a large number of insured units. High participation in the program is an inverse function of the premium. In other words, Federal crop insurance shares with other insurance the "circular" problem of seeking low premiums to attract high participation to make it possible to offer low premiums to attract high participation, and so on.

Not only is high participation an inverse function of premium, but it is also a function of net gains to be obtained from the insurance purchase. Premiums are high or low only relative to benefits received. It therefore becomes a function of the potential buyer's knowledge of available benefits, which in turn is a sales function. Most non-compulsory insurance must be sold, and Federal crop insurance is no exception. True, it is not in direct competition with other insurance companies, but, like other insurance, it is in competition with other choices available to a buyer as he spends his income. Applying the conditions necessary for maximizing satisfaction, the individual will purchase insurance if his evaluation of the gains from buying insurance relative to its cost is at least equal to the same ratio in other choices available to him. 33/ The function of selling is to inform the buyer of gains to be obtained by the purchase of the product--in this case, crop insurance. Early in the history of crop insurance it was thought by some that, since Federal crop

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33/ Leftwich, Richard H., The Price System and Resource Allocation, Holt, Rinehart and Winston, New York, Rev. Edn., 1961, page 57: "The conditions necessary for maximizing satisfaction will be:

$$\frac{MV_x}{P_x} = \frac{MV_y}{P_y} = \frac{MV_z}{P_z} = \ldots."$$

See Chapter IV for further discussion of crop insurance relative to farmers' decisions.

insurance was to be sold at cost, it would not be necessary to actively sell it--that it would merely need be made available to the farmers. However, American people, including farmers, are acclimated to receiving information on goods and services via aggressive advertising and sales efforts. Therefore, there is little reason to expect that Federal crop insurance information can be competitively transmitted any other way than by using some of the same techniques that are used in causing farmers to choose other products.

Non-Randomness--Independence--Moral Risk

Federal crop insurance shares with other insurance the problem of lack of randomness of events or perils, and lack of independence between events and between insureds and events. In the first section of this chapter, randomness and independence between events were listed among the ideal requirements for insurability. One can scarcely conceive of a risk or the effects of a risk that cannot be influenced to some extent by the insured. Even life insurance involves the problem of how an individual can affect the length of his life by the way he takes care of his health, or by his occupation. Crop insurance risks can be influenced by the insured by his cropping methods, the dispersion of his farm, and his attitude about small losses. Particularly serious is the problem of adverse selectivity. No group of individuals is perfectly homogeneous, there being both above and below average risks within any insurance group. The problem is to avoid insuring a greater-than-proportionate share of the below-average risks.

If a moral risk is defined as a deliberate attempt to cause an insured loss, it is probably not as prevalent in crop insurance as in such types as fire insurance. The problem is more in the nature of buying insurance when the probability of loss is high and dropping it when it is low. Under present laws, this is more difficult than in the early days of crop insurance, because of earlier closing dates, continuous policies, and chance of losing experience credits.

Characteristics of the Insured Units

One characteristic that sets all-risk crop insurance apart from most other types of insurance is the extreme variability among the heterogeneous insured units, especially when compared with the total number of units. A comparable situation is that of large commercial fire risks. This characteristic often precludes accurate statistical predictability. In the experimental stage the problem of small numbers and high variability is particularly acute. Imagine opening the insurance program in a new crop area which is characterized by farms that vary in size from 100 acres to 5,000 acres of wheat, with soils that vary from the best of silt loams to shallow gravelly loams, with average rainfall varying from a critical 10 inches, up to 15 inches, with potential insureds who would have had an insurable loss once in thirty years to ones who would have had a loss once every three years, and with hail rates that varied from 7 to 12 percent. This is the situation that exists in almost any cash-grain county in Montana. Fire insurance rate-makers were confronted with a similar situation when they began to establish rates for commercial buildings.

Characteristics of Perils

Drouth is the principal loss-causing peril covered under crop insurance. It has the peculiarity of occurring in relatively small areas in some years, and in others, such as 1934 and 1952, occurred generally over the entire United States. In other words, geographic spread of risk does not guarantee randomness in the occurrence of drouth, as it tends to do in the case of fire. As shown in Chapter VI, where perils are considered in more detail, there is a significant correlation in the annual precipitation between various stations in Montana over the past 43 years. Therefore the randomness of the drouth peril must be achieved over time, rather than by geographic dispersion of risks. (This is not to say that the latter does not help. There is much less correlation between stations over the Great Plains, than within Montana.)

With respect to the problem of spreading of risk over time, crop insurance is comparable to types of insurance such as supplied by the

Lloyds Group, and the Federal Deposit Insurance Corporation. Hail insurance is faced with somewhat the same situation--generally over the United States the incidence of hail is worse in some years than in others. Reinsurance and trading insurance risks are means used by hail insurance companies to solve the time problem.

Other perils covered under crop insurance are either closely related to drouth, or are more random in character, within each year. Some insects tend to increase in severity with drouth. Some species break out in small areas, and may persist for two or three years until they either disappear naturally, or defenses are developed against them. Among the diseases, some rusts tend to occur in wet years, others appear in random outbreaks.

Achieving randomness of perils over time poses a special problem. Crop insurance, like most other insurance, is based on annual premiums. Also, there appears to be a tendency to evaluate its achievements on an annual basis, or at least over a very short period of years, not more than two or three years. However, even if the actuarial work resulted in perfectly accurate premiums, the loss experience would show consecutive years of depletion of reserves, and building up net losses.

Summary: All-Risk Crop Insurance Compared With Other Insurance

Federal all-risk crop insurance is a public institution, but different from most other public insurance in that it has no compulsory aspects. As a Federal institution, it enjoys potentially unlimited resources, enabling it to continue through catastrophic losses and to carry on extensive experiments over time. On the other hand, it is subject to public obligation and to political influence which causes conflict between policy and sound business management.

Though FCIC does not compete directly with other insurance companies, it does compete with alternative choices for income expenditure available to farmers. Because a large number of insured units is a requirement of insurability, high participation in crop insurance is a goal of management. Therefore, like all insurance, Federal crop insurance must employ selling

methods similar to those used in selling other products and services to farmers.

Crop insurance shares with other types of insurance the problem of imperfections of randomness and independence between events and between insureds and events. There are few risks which cannot be influenced by voluntary actions of the insureds. A particularly serious problem in crop insurance is avoiding adverse selectivity--insuring a greater-than-proportionate share of the below-average risks.

Like large commercial fire risks, crop insurance risks are characterized by extreme variability and lack of homogeneity, compared with the total number of units. This is a problem that is particularly acute in the experimental stages, when the insurance is being offered in a new county or on a new crop, until a large number of the potential insureds are participating in the program.

The nature of drouth occurrence (the most important loss-causing peril in crop insurance--see Chapter VI) is such that randomness can be achieved only through time. Although geographic spread is an aid to randomness, it is not sufficient. This is one reason why the achievements of the Federal crop insurance program cannot be evaluated on an annual basis.

CHAPTER III

HISTORY OF CROP INSURANCE

The research problem is to seek ways by which the Federal crop insurance program in Montana can be improved. If history is to be of value to the solution of the problem, it should provide some answers to the questions, "What was the program intended to do in the first plant?" and "What were the principal problems encountered?" Therefore, the purpose of this history is to abstract some answers to these questions, rather than to rewrite the general details of all-risk crop insurance history, which have been ably treated in previous studies. 1/

The Congressional Record of Crop Insurance

Congress was the focal point of efforts to develop a Federal all-risk crop insurance plan, so it seems that the Congressional Record is the best place to find the answers to these questions. The following is a chronologically arranged review of the more pertinent remarks and events during the progress of the crop insurance program through Congress. This is intended to supplement, rather than to repeat, the previous, more comprehensive histories.

Crop insurance entered the Congressional Record in 1922 with the introduction of HR 10294, to establish a bureau of farm risk insurance in the Treasury Department. 2/ In support of the bill, Representative Edward King of Illinois presented probably the most comprehensive report and analysis of the crop insurance problem that is found in the entire Congressional record of crop insurance. (See complete remarks in Appendix B).

1/ See Buckler, James L., All Risk Crop Insurance, (A thesis submitted to George Washington University) FCIC, USDA, Dec., 1950. Since this thesis is not generally available, Chapter I, Endeavors of Private Companies, is reproduced in the Appendix of this study.

Also see Halcrow, op. cit., pp. 22-25, where he briefly reviews the private and foreign experiments with all-risk crop insurance. Of particular value is his list of references relative to crop insurance history.

2/ Congressional Record, Vol. 62, Part 13, 67th Congress, 2nd Session, February 6, 1922, page 2205.

HR 10294 proposed an

> Advisory board of three insurance experts, to be paid not to exceed $25 per day while actually working. . . to aid the director and the Secretary of the Treasury in publishing a standard form of farm risk policy and to fix reasonable rates of premiums. 3/

The required use of qualified insurance personnel was apparently considered essential to the program in 1922, but was not included in the final bill that was passed in 1937. When the program was put on an experimental basis in 1947, the requirement was added to the bill by amendment.

Prompt payment of losses and provisions for adequate capital were recognized in the 1922 bill as important to successful operation of an insurance program. Prompt loss settlement is favorable to participation because indemnity and service are tangible evidence to the insured of what he purchased. That is why private companies in other lines of insurance stress prompt settlement and service in their promotional programs. Adequate capital is not only necessary for prompt service, but is also a requisite for bridging the uncertainties of the experimental years.

King stressed the ways by which the need for crop insurance was tied in with other sectors of the economy. He felt that a stable food supply was as important to the consumer as it was to the producer, and that a stable food supply was a function of the availability of capital. In 1922 the critical credit problem resulting from severe crop losses involved loans for seed. We now know that readily available credit has been responsible not only for a stable food supply, but also for the abundance of food, and the remarkable efficiency in food production. King argued that if uncertainty resulting from frequent crop failures could be eliminated, banks would be more willing to make loans. Today, banks are using the crop-insurance assignment privilege to bolster their loans.

The intention of the bill was to make the crop insurance bureau entirely self-supporting. This feature is not included in the present law,

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3/ Ibid., Part 13, March 3, 1922, page 13522.

which only requires premium sufficient to pay the indemnities. However, adverse political pressure from mounting public debt combined with declining farm vote may force crop insurance to become a completely self-supported program.

King included a statement of features necessary to a successful program by V. N. Valgren, at that time associate agricultural economist of the Department of Agriculture, and author of several brochures and articles on crop insurance. Valgren stressed the importance of defining the insurance unit to be the entire farm or at least the total acreage of a given crop, and "adjustment be made on the basis of average yield of such acreage." 4/ The insurance unit so defined, has since become a critical feature of the present program, and an important factor influencing the level of premiums and farmer participation in the program.

He also warned against excess coverage, citing cost as an appropriate limit:

> The insurance must cover only such crop damage as will result in serious financial loss to the farmer. This means that only a reasonable amount of insurance an acre must be written. For establishing such reasonable amount the average yield and price for a series of past years is perhaps the best basis. . . . The part of the income or yield guaranteed by the contract . . . should not exceed the value of labor and other costs, including rental, that are actually lost to the insured in connection with the crop. 5/

This is an incomplete definition of "investment in the crop," but is as precise as any found in all the crop-insurance debates and acts. "Other costs" may or may not include normal profits. Furthermore, the term "rental" itself must be defined before it can be operational in this context.

Valgren argued that all perils must be covered. This is a modern concept of insurance that has been developed in many lines. His argument

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4/ Valgren, V. N., see King, Appendix B.

5/ Valgren, see King, Appendix B.

was similar to that used today in selling "blanket" type policies, that

> Insurance which protects against certain perils and leaves the insured exposed to total loss from other perils beyond his control is not real crop insurance. 6/

He urged that the moral hazard should be avoided by the limited coverage feature. There should be no encouragement to profit from mismanagement. This problem is critical to successful insurance management. Other methods of coping with it will be discussed later in this study.

An important observation was that

> The method of adjusting loss must be such that the insured will receive indemnity for crop damage in the amount or on the basis that he is led to expect from the figures indicating the amount of insurance per acre. 7/

It is considered important in public relations in the field of insurance that not only should an insured be well informed on coverage he purchased, but that adjusting of losses must also be in conformance with coverage he had reason to assume he purchased. Changes were made toward this end as the program was developed.

Valgren urged that the insureds should understand that the most important benefit from insurance is protection, not the receipt of loss indemnities. Lack of this understanding is probably the most serious barrier to a sound insurance program. In all kinds of insurance there prevails a desire on the part of insureds to get their premiums back in indemnities. This desire remains a primary factor causing lack of continuity of participation in crop insurance. He concluded his statements with a recommendation urging economy of administration. He referred to the fact that farm organizations in other countries have been known to promote economy in administration of insurance through group action, and suggested that farmers' organizations in the United States might make a contribution along this line.

6/ Ibid.

7/ Ibid.

Additional ideas were contributed to this early proposal by letters and speeches which were entered in the Record:

R. M. Bissell, president of the Hartford Fire Insurance Company, had developed little faith in actuarial methods in all-risk crop insurance:

> As regards crop insurance, we do write crop insurance; but having had our fingers severely burned in experimenting with this form of insurance, we are now proceeding in a far more careful fashion. . . . After nearly three years of experimentation, during which time we have lost a very large sum of money, we have finally come to the conclusion that insurance on the large crops can only be undertaken on what might be called a banking basis; that is to say, the amount of insurance must be limited to what a bank would under ordinary circumstances advance to the farmer to enable him to finance the making of a crop including harvesting. 8/

Whether such non-actuarial methods can be called insurance has been debated, but the problem is nevertheless well understood in the insurance industry.

N. C. Langford, cashier of the First State Bank of Celina, Texas, spoke favorably for the proposed crop insurance program. He referred to the need for crop insurance as a measure which would prevent financial disaster from drouth. In offering his cooperation in investigating the feasibility of the plan, this banker recognized the importance of Federal crop insurance as a measure enabling farmers to bridge the financial gap caused by disasters over which the farmer had no control. One should not overlook the fact that these were desperate times. There was a general demand at this time for economic relief for the farmers, whether it be through crop insurance or other means. Federal crop insurance, however, was looked upon as more permanent and palatable than relief measures.

T. C. Power, president of a Bismarck (North Dakota) bank, said

> Agriculture is the only industry that cannot obtain insurance. It cannot buy insurance. If it could, bankers would furnish money for the cost of feed and labor. 9/

8/ Bissell, R. M., see King, Appendix B.

9/ Power, T. C., see King, Appendix B.

Here was a banker stressing the improvement of credit availability through crop insurance.

The Wallace's Farmer of Des Moines in 1922 said,

> The businessman who has perhaps ten times as much control over his production conditions and his market as the farmer nevertheless removes uncertainty even more from his business by insurance. . . . Now it occurs to a businessman that it might be well for farmers to use insurance far more extensively than they do. Theodore Price, editor of Commerce and Finance, in an open letter to Secretary Wallace, suggests that the Department of Agriculture establish a crop insurance bureau. Mr. Price, like all businessmen, is rather against putting more government into business, but thinks it might be well for the Government to start a project of this sort, insuring typical farmers in representative crop-growing areas, with ideas of securing data after a number of years upon which rates might be worked out for a vast new insurance system. 10/

This was a proposal for a government experiment to furnish a basis for private insurance, an idea that was expressed several times in future debates on all-risk crop insurance bills.

Dr. Andrew Soule, President of the State College of Agriculture, Athens, Georgia, attributed economic development in part to the ability to insure:

> Undoubtedly insurance has proven of benign value to many classes of society and has made possible the development and expansion of many phases of our industry that would have languished but for the fact that those engaged in the business were in position to insure themselves against loss. 11/

Several points important to this study were brought out by D. G. O'Shea, president of the Federal Land Bank of Spokane, when he wrote in the Red Cross Echo:

> It does not seem reasonable to expect the farmer to continue to take all the chances. It is not suggested that he should receive something for nothing, but that something should properly be devised for affording him a reasonable protection for

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10/ Wallace's Farmer, see King, Appendix B.

11/ Soule, Andrew, see King, Appendix B.

> the chances he necessarily has to take when contending with the elements, over which no control can be exercised. 12/

He referred to the Montana State hail-insurance law, and added:

> Some method should be devised to protect the farmer against other failure. It is not to give him a charity or a gift, but to furnish him with insurance, to the end that he will be sure to receive at least what it has cost him to plant the crop, plus a small remuneration for his labor in the event that there be an absolute failure caused by weather conditions over which he could exercise no control. 13/

Here again is an attempt to define the appropriate level of coverage, but the "cost to plant the crop" is not explicit as to whether it includes any among a variety of items, such as rent, normal profit, depreciation, seed and fuel. He recognized that costs should include some "profit" or living expenses:

> Reasonable provision can easily be devised for determining losses, which may be limited to a stated maximum figure sufficient only to cover the cost incurred and a small margin for labor and living expenses. 14/

O'Shea was aware of the possibility of moral risk:

> A scheme of insurance can readily be worked out under the operations of which no unworthy person could receive a benefit; the cost may be borne by the farmers themselves or the National Government may contribute to the fund; the fund should be administered by the Government. 15/

Finally, he suggested the favorable effect of crop insurance on credit:

> There seems to be a specific need at this time for this form of legislation; the operations of the Federal land banks can be better assured and extended if such insurance be provided. 16/

Theodore Price (editor of Commerce and Finance) contributed to the development of the crop insurance program with his paper submitted to the Agricultural Conference convened by the President January 23, 1922, and

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12/ O'Shea, D. G., see King, Appendix B.

13/ Ibid.

14/ Ibid.

15/ Ibid.

16/ Ibid.

included in the Congressional Record. 17/ He strongly favored a Federal study of the feasibility of crop insurance. (See Appendix for complete text.) Price stressed the need to determine if agricultural perils are insurable; that is, whether over a period of years the frequency of occurrence of distinctive phenomena would be such as to establish a predictable pattern, and were independent of the management of the producer.

The utility of protection was pointed out by Price, quoting Charlton Thomas Lewis:

> The value of insurance as an institution cannot be measured by figures. No direct balance sheet of profit and loss can exhibit its utility, the insurance contract produces no wealth. It represents only expenditure. . . . But the results in the social economy, the substitution of reasonable foresight and confidence for apprehension, and the sense of peril, the large elimination of chance from business and conduct have a supreme value. 18/

For society, the direct economic contribution of insurance is the utility of protection, since premiums must cover losses plus operational costs. A part of the utility of protection is the favorable net economic effects on production efficiency through better capital utilization and economic stability.

Coverage level and determinability of loss were problems of crop insurance pointed out by Price:

> Then there is the question of determining or measuring the farmer's loss. Manifestly it would be unwise to allow him to insure his crop for any valuation he chose to put upon it. An overvaluation would be an incentive to neglect and extravagance and would lead to the presentation of many unfair or fictitious claims. On the other hand, an undervaluation would not give the protection required. Insofar as any rule has been applied by those companies who have written crop insurance the practice seems to have been to insure the actual cost of production up to a certain maximum per acre and to require that the farmer

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17/ Congressional Record, Vol. 62, Part 13, 67th Congress, 2nd Session March 3, 1922, page 13524.

18/ Price, Theodore, op. cit., see Appendix C., (Quotation from Charlton Thomas Lewis, Ph.D., in Encyclopedia Britannica.)

> insured must furnish satisfactory proof that the amount claimed has been actually expended. In some cases crop policies have also contained a provision making the farmer a co-insurer for 20 percent of the risk, so that he would have an additional incentive to avoid loss. 19/

Co-insurance, whereby the insured shares in the loss, is a tool that should be considered when attacking the problem of providing more adequate coverage without prohibitive increases in premium.

Like others who were averse to a strictly-government program, Price suggested that the proposed program should provide experience and methods by which private companies could eventually write crop insurance:

> Would it not therefore be well for the President or Congress to immediately appoint a committee to make a careful study of the subject with a view of ascertaining whether it would be practical and expedient for the government to establish a crop insurance bureau from which the farmer could buy policies . . . and from which, after a few years, the larger insurance companies who were willing to do the business could obtain data upon which to base rates. 20/

The Presidential Agricultural Conference of January 1922 resulted in a recommendation that the United States Congress investigate the subject of crop insurance. In August of 1922 the first Congressional action was taken on crop insurance with the passage of Senate Resolution No. 341, authorizing an investigation by a committee, providing only expense of a stenographer, later amended to include an additional amount for travel expenses and witnesses. The committee members were Senators Smith (South Carolina), Keyes (New Hampshire) and McNary (Oregon) who at this time was the agricultural leader in the Senate, and during subsequent years established himself as the "dean" of agricultural legislation. No committee results are recorded in the Record, although reference was later made to information compiled by the committee.

By resolution to investigate, crop insurance was brought up in the 68th and 69th Congresses, but legislative action apparently died in

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19/ Ibid.

20/ Ibid.

committee, or was crowded out by emergency farm relief legislation.

In December, 1927, Senator Bruce of Maryland submitted Senate Resolution No. 51:

> Resolved, That the Secretary of Agriculture is hereby requested to report to the Senate at the beginning of the second regular session for the Seventieth Congress his views as to whether the insurance of the farmer by the Federal Government against droughts, floods and storms would be consistent with sound governmental and economic policy; and, if so, under what conditions such insurance should be issued. 21/

The resolution was passed, but no results were reported, again apparently because legislators were preoccupied with emergency farm legislation.

In May, 1930, a bill (SB1164) was passed by the Senate authorizing the Secretary of Agriculture to investigate all phases of crop insurance. However, it was lost in the House agricultural committee.

In February, 1932, Senator Sheppard (Texas) introduced SB3793, authorizing the Federal Farm Board (created in 1929) to enter into re-insurance contracts with private insurance companies which insure growing crops against perils to which they are normally subject equal "at least to a substantial part of the cost of producing any crop" as determined by the Board. 22/ This measure was specifically intended to subsidize development of crop insurance through private companies. This proposal died in committee.

Until 1936, little was accomplished in crop insurance legislation. On September 19, 1936, President Roosevelt, in a letter to the Secretary of Agriculture, appointed a crop insurance committee for the purpose of working out a plan of crop insurance. He recommended the use of extensive crop insurance studies then being made in the Department of Agriculture. In his mind, supply stability (and resulting price stability) were to be expected as one of the fringe benefits of crop insurance:

21/ Congressional Record, 70th Congress, 1st Session, Vol. 69, Part 1, Dec. 13, 1927, page 546.

22/ Congressional Record, Vol. 75, Part 4, 72nd Congress, 1st Session, February 24, 1932, page 4591.

> In the past three and one-half years, the Government has helped farmers to meet emergencies of two kinds, the first was collapse of prices resulting from huge surpluses for which the foreign markets disappeared. The second was a failure of crops in wide areas resulting from drought. Each of these emergencies, except for Government action to assist farmers, would have had devastating consequences to consumers and business as well as to farmers. The time has come to work out permanent measures guarding farmers and consumers against disasters of both kinds. Crop insurance and a system of storage reserves should operate so that the surpluses of fat years could be carried over for use in the lean years.
>
> Measures of this kind should make three important contributions to the general welfare of the country as a whole; first, protection of the individual farmer's income against the perils of crop failure or price collapse; second, protection of consumers against shortages of food supplies and against extremes of prices, and third, assistance to both business and employment through providing an even flow of farm supplies and the establishing of stability in farm buying power. . . . I am especially interested in its (Department of Agriculture) studies of a plan providing for the payment of premiums and insurance in commodities. 23/

The President was thinking of crop insurance being tied in with other programs:

> By making this insurance available only to farmers cooperating in farm and soil conservation programs, the plan would be safeguarded from the price dangers which the Federal Farm Board operations invited in the years from 1929 to 1932. 24/

The President was undoubtedly aware of the need for political support when he mentioned the benefits accruing to business and consumers as well as to farmers; but others stressed the economic soundness of these benefits (such as lessening the general farm relief load in times of recurring drouth) in subsequent debate, as the basis for government subsidy of the crop insurance program.

23/ House Document No. 150, "President's Committee on Crop Insurance," 75th Congress, 1st Session, February 18, 1937, page 16.

24/ Ibid., page 16.

In his letter to the Secretary, the President recommended a program of crop insurance on wheat for the crop year 1938 in concurrence with the committee report, with the addition of other crops as producers requested them and as the wheat program provided experience in applying the principles of crop insurance. 25/

The committee made the following recommendations, some of which have not been carried through to the present program, as noted:

1. The administration of the program should be assigned to the Department of Agriculture. (However, local committees in charge of the other farm programs have not proven to be best for local crop insurance administration. Insurance selling and adjusting is too specialized to integrate with the administration of other programs.)
2. The amount of insurance should be determined by the average yield per the individual farm insured. (However, it has been found administratively more practical to establish areas for both rates and amounts of coverage.) It was suggested that county averages should be combined with individual farm yield, which is the equivalent of the present system of area rates combined with experience credits.
3. Premiums and indemnities should be paid in terms of bushels of wheat, with the result that there would be accumulation of stocks in years of abundance, to be placed on the market in years of shortages. (However, the storage principle has been dropped.)
4. Because of the relatively short history upon which to base premiums, the local committees should be given discretion to make adjustments of rates under special circumstances, such as a "super-abnormal" loss occurrence in the base period.

25/ Ibid., President's Letter of Transmittal, page III.

5. A scheme to pay premiums in good-crop years. (Although this idea is currently discussed, it has not been implimented.)
6. Timely payment of losses was stressed as an essential part of any plan.
7. Compulsory compliance with other programs for participation in crop insurance was recommended. (However, compulsory insurance has not been considered acceptable by farmers in the United States.)
8. Finally, the committee stressed the value of crop insurance in improving the availability of credit.

Nothing with respect to "investment-level" of coverage was mentioned in this committee report. 26/

Following the report of the President's Committee on February, 1937, Senate Bill 1397 was introduced, providing for establishment of a crop insurance corporation in the Department of Agriculture with provisions essentially as recommended by the President's Committee. 27/ This was the beginning of the lengthy Congressional debates on the first crop insurance act. Leading proponents of the bill were Senators Pope (Idaho) and McNary (Oregon). The latter was reluctant to propose a crop insurance plan as a permanent program, but rather as an experiment that would demonstrate the feasibility and practicability of crop insurance. He felt that it would soon be operated and controlled independent of the government.

The influence of the over-all problem of stabilizing farmers' income was prevalent in all the Congressional debate, and was the reason why storage of wheat accumulated as insurance reserves was considered an important part of the bill.

There was general agreement that the coverage level should necessarily be limited, but no attempt was made to relate it to investment in the

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26/ Ibid., Report of Committee, pp. 4ff.

27/ Congressional Record, Vol. 81, Part 1, 75th Congress, 1st Session, page 956, February 8, 1937.

crop. McNary asked, "Do the losses against which the farmer insures include prospective profits, or are they based on cost of production?" Pope replied, "On neither; they are based upon the average yield over a period of years; . . . ." 28/ Then he discussed the 50-percent and 75-percent (of average yield) levels, but made no more mention of profit, or costs of production.

Using the name "insurance" was challenged by Senator Malony (Connecticut) on the argument that "this was not truly an insurance proposal as we understand the word 'insurance.'" 29/ He said that it was an equalization bill, involving subsidy and commodity reserves, and an experiment. He proposed an amendment to substitute "equalization" for "insurance," which was rejected.

The bill provided that administration costs be borne by the Government, but that costs of local committees could be loaded on the premiums.

The importance of Senate Bill No. 1397 was that it contained essentially the main provisions contained in the act which was passed by both houses and signed by the President as Title V of the Agricultural Adjustment Act of 1938. By this time the basic organization, coverage, and general principles had been agreed upon. The main problems remaining to be solved were developing actuarial data and methods, determining the crops to be insured, degree of tie-in with other agricultural programs, local sales and administration methods, level of coverage available, underwriting, and extent of government subsidy. The debate from here on was concentrated on these problems.

An attempt was made in late 1938 to require mandatory participation in other agricultural programs, but this attempt was again stopped. Representative Edward Rees (Kansas) expressed a feeling shared by the majority of the Congressmen that crop insurance, though attached to the Adjustment Act, should be considered an independent program:

28/ Ibid., Part 3, pp. 2753ff, March 25, 1937.

29/ Ibid., page 2865.

> I . . . do think it is unfair for the Department of Agriculture to provide and promulgate regulations and interpretations that will require wheat farmers to comply with other features of the 1938 Agricultural Act, in order to have Federal crop insurance. . . . Crop insurance does not affect the Nation's supply or demand, or surplus or shortage of crops. No farmer should be denied a right to take such Federal crop insurance if he is otherwise qualified--just because he does not choose to join a compulsory or reduction program. 30/

The Crop Insurance Act was passed with the agreement that coverage would be extended only to wheat, because more experience data was available on wheat than on other crops. But it was also passed with the assurance to Southern senators that cotton and tobacco would be added as soon as sufficient experience was accumulated on wheat insurance. The Northern congressmen obviously had in mind that at least five year's experience would be necessary before the soundness of wheat crop insurance could be judged. On the other hand, some of the Southern congressmen just as obviously had no intention of waiting that long to add cotton. In 1939, after one year of wheat crop insurance, a bill was passed to extend the program to cotton. The debate on the bill reveals that there were other than economic considerations involved in adding cotton:

> Senator Bankhead (Alabama): "The Department of Agriculture is satisfied with the administration of the wheat program, and the Department prepared the bill now before the Senate and brought it to me, with the statement that they wanted cotton put on the same basis with wheat."
>
> Senator Vandenburg (Michigan) questioned the adequacy of one year of experience with the wheat program.
>
> Senator Bankhead on being questioned could give no final loss experience but said the Department made a profit on wheat. "We have not unduly hurried the Administration. . ."
>
> Senator Austin (Vermont) asked for expected loss and premium figures for cotton, but did not get them. He asked for loss experience with cotton over the past ten years.

30/ Congressional Record, Vol. 84, Part 3, 76th Congress, 1st Session, page 2454.

Senator Bankhead said he had none. "We have as to wheat. We have no way that I know of to estimate what the situation may be with respect to cotton. The liability in the case of wheat . . . . is, on the average greater than it is with cotton." But the Senator presented no evidence on the record.

Senator Austin: "And there is absolutely nothing to go on?"

Senator Bankhead: "Nothing but the judgment of the Department that this program ought to be put into operation. . . . . I am sure the Senator (Austin) recognizes that in any program covering basic agricultural commodities cotton should be included. There is a greater population on the farms on which cotton is raised than on farms involving any other agricultural commodity. Cotton farms contain about one-half the total farm population."

Senator Russel (Georgia): "The Senator from Alabama has just stated. . . . that the original venture in wheat insurance had proved very successful, and would result in a profit to the Government. There is no reason to believe there would be a greater loss in cotton than there would be in wheat. . . ." He made other statements indicating that on the basis of the one year experience on wheat and ". . . . if we have the same experience over a period of years. . . ." the Government will make a profit.

Senator Taft (Ohio): "Is it fair to say that the program is no longer experimental in the field of wheat, as it was supposed to be in the beginning?"

Senator Bankhead: "I think we have had a very representative experience with it. The Senator knows the probabilities as well as I do, and about how long it would take to make a certain test. . . . I do not think there is as much risk in insuring cotton as there is in insuring wheat. The usual cause for loss in crops is abnormal weather. Except in one or two years, during the past eight or nine years we have had normal weather and normal crop conditions in cotton." 31/

The economic significance of the above exchange was the disregard for amount of time required for sufficient experience to establish a sound base for insurance. Senator Russell apparently realized the danger of political conflict with sound economics when, in spite of pressure that must have

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31/ Congressional Record, Vol. 84, Part 8, 76th Congress, 1st Session, July 6, 1939, pp. 8682 ff.

been put upon him, he spoke in favor of going slowly in adding tobacco to the program because it might jeopardize the whole program. 32/

Senator McNary continued to express an urgency for soundness:

> I think that crop insurance, to be effective, must be based upon scientific data gathered through a period of years by the Department of Agriculture, and the application must be along the line of philosophy and theory of the old insurance companies in issuing policies. 33/

He was in favor of the program becoming completely self supporting.

But McNary's was a voice crying in the wilderness. Southern Senators took every opportunity to mention the political strength of the cotton producers. Senator Bilbo (Mississippi) said:

> I desire to direct attention to the fact that if the cotton growers in the Cotton Belt, which extends from California to North Carolina, representing 2,000,000 farmers, are anxious to have the legislation enacted, I cannot understand how any Senator could get their consent to vote against it. 34/

To attribute political pressure only to the South would be unfair, because, this being a time of chaos in the agricultural economy, pressures from all sides for economic relief were extremely strong. However, to ignore the political interference with the economic soundness of the program would be unfair to those called upon to administer it.

Representative August Anderson (Minnesota) questioned the length of the wheat experiment, saying that it should be five or six years.

> We have had one full year of crop insurance for wheat . . . . we would find the organization lost money; in other words it lost more than 2,300,000 bushels of wheat in addition to the administrative cost which ran about $4,800,000. If we are to set up a sound insurance corporation--one that will eventually and finally cover all farm commodities--we must act on sound actuarial experience rather than be

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32/ Congressional Record, Vol. 84, Part 9, 76th Congress, 1st Session, July 19, 1939, pp. 9468 ff.

33/ Ibid.

34/ Ibid.

> motivated by our political aspirations in order to satisfy some section of the country. 35/

But the bill making crop insurance available for cotton was made law after only one year experience on wheat.

Justification for subsidy of the crop insurance program was related to the emergency relief problem, and also to benefits accruing to segments of the economy other than farming. Representative Sabath (Illinois) quoted a letter from a South Carolina producer:

> If this bill is passed. . . .it would absolutely keep farmers off WPA and relief rolls, and would give them three-fourths of the normal value of their destroyed crops, to be used in paying their taxes and other obligations, whereas WPA work and money spent for farmers' relief simply goes to maintain them and their families, and leaves them with their various obligations carried over to the next year unpaid. 36/

Repeatedly, Congressmen referred to the preventive effect of crop insurance on the demand for emergency farm relief.

Representative Larrabee (Indiana) pointed out the importance of severe losses to other businesses:

> Such losses, occasioned by adverse weather conditions, not only rob the farmer and his family of their buying power, but that loss of buying power in the channels of trade is immediately felt by those people in towns and cities who are maintained directly by income from other pursuits and occupations. 37/

By 1943, the major problems encountered in crop insurance were becoming obvious. A continuity of high participation was accepted as a requisite of a successful program. The three-year contract has been made available and the 1943 crop was insured on this contract. Consequently, when a move was made to cancel the program, cancelling of these three-year

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35/ Congressional Record, Vol. 86, Part 5, 76th Congress, 3rd Session, April 19, 1940, pp. 4774 ff.

36/ Congressional Record, Vol. 86, Part 5, 76th Congress, 3rd Session, April 19, 1940, page 4748.

37/ Congressional Record, Appendix, Vol. 86, Part 14, 76th Congress, 3rd Session, March 14, 1940, page 1442.

contracts causes considerable opposition. This is just one of many cases which illustrate the importance of having several years time to work out a successful insurance program.

The problem of stratification was raised when, after three years of experience, some states had a loss experience in the red and others in the black. The question is: To what extent can favorable loss experience in some states be used to pay unfavorable experience in other states, and over what period of time must the indemnities balance the premiums? In the debate on the continuance of the program in 1943, Representative Case (South Dakota) argued:

> The astonishing fact is that the bank has been broken on this insurance proposition by the grand old states of Indiana, Illinois, Iowa, Kansas and Missouri. The total indemnities paid out last year exceeded the premiums collected by about $3,000,000 or $4,000,000. Four of five Central States accounted for more than that much and the truth is the states of North Dakota, Montana, and South Dakota helped to provide the surplus to reduce the amount of loss. . . . .The net result is that for the four years in which Federal Crop Insurance has been in operation, North Dakota has paid in $1,150,000 more in premiums than she has received in indemnities. 38/

The main arguments that resulted in the suspension of (lack of appropriations for) the program in 1943 were: Losses to capital (over $17 million in wheat in four years), administrative costs ($20 million in wheat in four years), relatively low participation (one-third of wheat farmers and only 10 percent of cotton farmers.) 39/

World War II influenced the demand for crop insurance, and some of the program's proponents argued that farmers deserved protection of their production costs comparable to other wartime industries, even to the extent of completely subsidizing the premium on scarce strategic crops.

38/ Congressional Record, Vol. 89, Part 3, 78th Congress, 1st Session, April 19, 1943, page 3575.

39/ From debates on liquidation of FCIC, Ibid., pp. 3569-3580.

> I am only asking that the farmer producing war crops. . . be guaranteed on his actual investment. . . . Insurance of investment in the crop has been suggested in these amendments. . . . Under the proposed amendment he would be paid 75 percent of any loss on his investment as reflected by the cost of producing the crop. 40/

In November, 1944, HR 4911 was introduced to amend the Federal Crop Insurance Act, reinstating the program. There were several provisions aimed specifically at elimination of the above mentioned problems. Excessive coverage had been considered as a reason for excessive losses, and as a result an attempt was made to define "investment in the crop" more accurately. Though this provision was later eliminated from the bill, the definition is of value here to show what the congressmen and the corporation had in mind:

> Such insurance shall cover a percentage to be determined by the Board not in excess of 75 percent of the recorded or appraised average yield of such commodities on the insured farm for a representative period subject to such adjustments as the Board may prescribe. . . . Provided, however, that such insurance coverage shall not exceed the investment in the crop based on the cost, as determined by the Board, of preparing the land, or labor, seed, planting, cultivation, disease or insect control, harvesting, ginning, hauling to market, fertilizer, irrigation, use of the land, and other applicable costs as determined by the Board. 41/

Here again is an incomplete definition of "investment in the crop," omitting any mention of normal profits or management costs, and depreciation, and giving the Board open authority to add and determine "other applicable costs." Obviously, as long as cost is not more specifically defined, there is no point in including such a coverage limitation in the

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40/ Congressional Record, Vol. 89 Part II, 78th Congress, 1st Session, October 11, 1943, page A4217.

41/ Congressional Record, Vol. 90, Part 6, 78th Congress, 2nd Session, Nov. 21, 1944: Amendment to subsection (a) of Sec. 508 of Federal Crop Insurance Act.

act. Yet Congressmen continued to emphasize "investment in the crop" as a vital coverage limit. Representative Pace (Georgia) said,

> It seems to me that the committee has requested the House to do today what any group of businessmen would do. We have had a crop insurance program that was unbalanced. . . . It offered in many cases an inducement to a man to abandon his crop on account of the fact he could gain more through insurance than he could by completing the crop. . . . The committee comes to you today and it strikes out that program and goes back to rock bottom. That is, it seeks to insure only the farmer's losses. That is his investment in the crop and no more. That is exactly what a fire insurance company does. 42/

HR4911 would have provided for entering new crops on an experimental basis and for research. A minimum number of farms per county was established, as an attempt to lessen administrative costs. The actuarial procedures were to be tightened up to prevent dissipation of capital.

For the first time, sales effort was recognized as a necessary feature of a successful insurance program; HR4911 would have provided for local publicity of losses paid on individual farms. In opposition to sales effort, Representative Ben Jensen (Iowa) said,

> I wonder if the gentleman will not agree, however, that it is not necessary to send out a big sales force to sell something the farmer knows about already. . . . It seems to me the farmers who want it will take it anyway.

To which Representative Sam Hobbs (Alabama) replied,

> . . .No insurance sells itself. I may say to the gentleman from Iowa . . . that not a single insurance institution has been built without an adequate selling force of agents, that frequently seems too large. 43/

The question of tying crop insurance with other farm programs was again brought up. Representative August Andersen (Minnesota) said:

> There is nothing compulsory in this bill, and if there was anything compulsory in the program, I would not be for it.

42/ Ibid., page 8300.

43/ Congressional Record, Vol. 90, Part 6, 78th Congress, 2nd Session, November 21, 1944.

> . . . They tried that out in the State of North Dakota a number of years ago on crop insurance and hail insurance, where every farmer had a premium put on his tax roll, but the farmers of North Dakota got disgusted with that and then the law was repealed. A thing like that will not work in the United States. 44/

A reference was made to longer-term contracts as a means to eliminating adverse risk selection, by Representative Flannigan (Virginia):

> I want to be in a position to give him a four- or five-year policy so that losses and benefits will distribute over a period of years. . . . It is to eliminate the selection. 45/

HR4911 did not pass. The loss experience and administration problems continued to arouse opposition to the crop insurance program during the next three years. In 1947 a bill was introduced (and passed) placing crop insurance on an experimental basis. Senator Aiken (Vermont) was asked to explain the bill:

> During the last few years there has been a pretty heavy loss in the insurance of crops. The committee felt that Federal crop insurance is rather in the experimental stage, and for that reason approved the bill, which reduces the scope of the crop-insurance program. We felt that if that were not done perhaps there would be no justification for continuing it at all. We thought at the same time that it should be continued on an experimental basis for some time longer. 46/

This act provided specifically for the first time, that insurance men should be included on the Board.

The present stage of Federal Crop Insurance in the United States was reached when the program was thus placed on an experimental basis in 1947.

Attempts by Private Companies

Attempts by private companies to write all-risk crop insurance reveal the principal problems encountered in the evolution of this kind of risk

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44/ Ibid.

45/ Ibid.

46/ Congressional Record, Vol. 93, Part 7, 80th Congress, 1st Session, July 3, 1947.

protection. The experiences of these companies are catalogued according to the problems encountered, which often provide the key to failure. 47/

Price Protection

The Realty Revenue and Guarantee Company in 1899 issued a policy including price protection with natural perils, guaranteeing an income of five dollars per acre for a premium of twenty-five cents per acre. The company failed, but it is not known whether because of trying to insure income or just because of mismanagement.

In a similar way, price was covered by two companies in 1917, but failure appeared to be due more to other factors.

In 1919 the Hartford Insurance Company introduced a type of policy designed to cover the cost of production. This involved price protection to the extent that, even though the yields remained constant, a price drop could cause the returns to fall below the cost of production. A combination of crop losses and a price recession resulted in severe losses to the company. In 1921, the company eliminated the price-protection feature, resulting in a drastic fall in participation. The company ceased operations after 1923.

Price declines were directly blamed for the failure of the Agricultural Protective Mutual Insurance Company in 1931 and 1932, though it wrote a policy that limited the maximum coverage to $2,000.

The Sowers Plan of Insurance in 1937 attempted to avoid the risk of price fluctuation by providing a minimum price to be used in computing production income. In spite of this limit, the company failed.

Availability of Capital

In all cases of private attempts to write all-risk crop insurance, it is apparent that the program covered a period of not more than three years. None of the companies were in a position to nor desired to make changes and experiment over a very long period of time, even the Hartford

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47/ Taken from Buckler, op. cit., pp. 3-7. (Also see Appendix A).

and the Home Insurance Companies. The uncertainties in risk estimating were presumably too great for the capital available for experiment.

Miscellaneous Problems

Inadequate analysis of the problems involved was evidently basic to failure of private attempts. There was failure to spread the risk out either geographically or over time. Two of the companies in 1917 failed to cut off policy-writing each year before the farmers were able to predict their crop prospects. The same two companies failed to separate bank-security interests from underwriting responsibilities--the local agents for insurance were also officers of local banks. Where companies attempted to insure the cost of production, they failed to properly define the coverage.

Notable in the efforts of the private companies was their attempt in almost every case, especially in the beginning to insure either a certain income or cost of production. When the Hartford attempted to change to a policy insuring only yield the participation fell off critically. There remains the unanswered question: Would it have been possible for any of these comapnies to have succeeded if (1) none of them had attempted to insure income and therefore price, and (2) they had been able to obtain sufficient capital to finance research and experimentation during the beginning years?

It is to be noted also that the private attempts were all made during economically desperate times in agriculture, particularly in areas where the insurance was written. The Bankers of Montana and the National Union of Pittsburgh started writing in 1917, encountering a period of severe drouth. The Hartford started writing in 1919, a severe drouth year in the Plains, and continued during the agricultural depression of 1921. The Agricultural Protective started writing in 1931, during the Great Depression. Agriculture was still in depression, especially price-wise, when the Sowers Plan was tried in 1937. The unanswerable but pertinent question that can be raised here is to what extent can even private companies be pressured into a conflict between good business methods and the demands of

potential insureds. A logical assumption is that crop insurance is beset with another unique characteristic: There is little demand for it in relatively good times but demand pressure becomes heavy in bad times. Evidence of this is that the first congressional demand for Federal crop insurance was in the depression of the early 1920's, and the pressure for its final passage was during the Great Depression.

Foreign Crop-Insurance Attempts

Little of value for this study is to be found in the foreign attempts to provide all-risk crop insurance. The early attempts are summed up by Halcrow:

> Crop insurance has been attempted in every major country of the world. Two general results have occurred. Either (1) the program was discontinued because of large underwriting losses, or (2) the program was continued only because the government (a) subsidized it and/or (b) made it compulsory. In no case has crop insurance become self-supporting on a voluntary basis.
>
> In foreign countries, crop insurance generally has taken some form of state insurance. One explanation of this is that the technical difficulties encountered have been too great to be handled by private companies with limited resources, since crop losses can approach the magnitude of a calamity or a national catastrophe. . . .
>
> Crop insurance was written for brief periods beginning in France in 1858, in Finland in 1860, in Germany in 1870, and in Denmark in 1910. In Sweden plans were made to insure crops but these plans were abandoned because of expected potential losses. In 1888, the Japanese government hired a German economist to study the feasibility of crop insurance. He recommended a plan for crop insurance but the Japanese did not institute crop insurance until 1938, at which time it was made compulsory. The Soviet government also has adopted compulsory crop insurance. . . . Compulsory crop insurance was instituted in Switzerland in 1920. Unsuccessful attempts were made to establish systems of non-compulsory crop insurance in Greece in 1927 and in France during 1929 to 1937. 48/

48/ Halcrow, Harold G., The Theory of Crop Insurance, Ph.D. Thesis, University of Chicago, 1948, pp. 22-23.

Canada met the crop-failure problem with the Prairie Farm Assistance Act in 1939. Although this act performed some of the functions of crop insurance, it did not operate as an insurance program:

> In a nutshell, the Prairie Farm Assistance Act was passed to provide direct financial assistance to farmers in an area suffering a crop failure.
>
> It is simply a type of financial aid--as the name implies--to permit farmers in a crop failure area to carry on their farming operations.
>
> At first glance payments made under the Prairie Farm Assistance Act appear to be a form of crop insurance. This is not so because the payments cannot be made on the individual farm basis. They can only be made on an area basis, and no area of less than a section can be taken into account in the computations and the making of payments. 49/

The Crop Insurance Act was passed by the Canadian Parliament in July, 1959. A principal difference between the Canadian Act and the U.S. Federal Crop Insurance Act is that the former is an enabling act under which:

> The federal government may enter into agreements with any province which establishes a crop insurance scheme to provide that province with assistance in the form of contributions and loans. The act does not set up any specific insurance plan but rather permits the federal government to assist the provinces by making direct contributions towards the cost of such a program. 50/

The Canadian Act allows the provinces to set up and operate their own programs, recognizing the request from farm organizations that both levels of government be involved, and also an idea that the provinces better understand their own problems.

Like the United States Act, the Canadian program recognizes the need for government assistance:

> In Canada the Act provides that the federal government will pay 50 percent of the administrative costs of any crop

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49/ Canada Department of Agriculture, Prairie Farm Assistance Act, An information pamphlet, August, 1961. See also Halcrow, op. cit., pp. 24-25 for details of the operation of the program under the PFAA.

50/ Canada Department of Agriculture, Reference Paper on Crop Insurance in Canada, Information Division, January, 1963, page 5.

insurance program plus 20 percent of the premiums paid in any year. The contribution of 20 percent of the premiums is similar to that paid by Canada to the Unemployment Insurance Fund.

. . . . . .

The federal government is prepared also to make loans in any year to provincial crop insurance schemes up to 75 percent of the amount by which indemnities exceed the aggregate of premium income plus reserves plus $200,000 in the same year. These loans are available because the financial resources of individual provincial governments could not cope with widespread crop failure or a series of failures. 51/

Insurance is limited under the act to 60 percent of the average yield per acre. "It is generally accepted that the 60 percent coverage is approximately equal to the 'out-of-pocket' costs of production." 52/

Insurance is not compulsory, except that 25 percent participation is required in any area covered by an insurance scheme before it can become operative. From the standpoint of the farmer, the operation is similar to that of the United States program.

Summary of Crop-Insurance History

As one reads through the Congressional Record of crop insurance, he cannot avoid being impressed by the fact that the program was developed during extremely distressing times for agriculture. The expressed purpose of the final Act clearly was to protect the farmer's investment in his crop, to keep him in business through periods of heavy crop loss from natural perils beyond his control, and to improve his ability to obtain credit in years of crop loss. However, mixed in with the expressed intent of the Act were arguments that it would decrease relief demands and even substitute to a certain degree for relief. The Congressional atmosphere was such that agricultural leaders were tending to push any measure that would make a contribution to stability of farm income and also to increases in real farm income. Certainly the crop insurance act was one of these

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51/ Ibid., page 6.

52/ Ibid., page 6.

measures. The pressure to bring cotton under insurance before a few years of experience could be compiled on wheat was evidence of submitting to political pressure to the detriment of a sound approach to the program.

During the less distressing times of the late 1940's and the 1950's, the pressure to continue the program came less from a desire to provide economic relief and more from a desire to enhance economic business stability. With the placing of the program on an experimental basis in 1947, it became vulnerable to political pressures and was forced more into the position of operating on a sound economic basis.

The intent (or goal) of using the crop insurance program to enhance economic stability through maintaining reserves in commodities became less meaningful when the crop supplies were in continuous surplus. Also the costs of handling commodity reserves were too great.

Some of the early promoters of crop insurance, such as Price and McNary, intended that the program eventually provide sufficient experience that private companies could build a private system of crop insurance. The charter of the FCIC contains such a provision. However, there is no indication that any private companies are interested in entering the field.

As far back as 1922, during the first Congressional efforts to enact the program, King and Price both recognized most of the problems that beset the crop insurance program today: How to eliminate the moral hazard; how to allow for the insured's control, both favorable and unfavorable, over the effect of insured perils; how to increase participation; how to avoid adverse selectivity; and how long a period should be considered in the actuarial base. The remainder of this study will be concerned with how these problems are being handled, and how methods can be improved.

Finally, a basic difference in general economic conditions in agriculture should be recognized: As noted, when the Act was originally passed agriculture was in desperate economic circumstances. An important change since the 1930's is that although many farmers are being forced out of business, they are now and have been able to sell out and be absorbed into

other parts of the economy. In the 30's the entire economy was economically distressed, whereas since that time the non-agricultural economy has been better able to absorb some of the agricultural population which would otherwise have been in distress. The demand for saving the "family farm" has all but disappeared. There will likely be less obvious justification for subsidy of farm programs than in the 30's. These changing conditions can be expected to have considerable impact on the ways the crop insurance program meets its problems. Chapter VIII will discuss these changes in more detail.

CHAPTER IV

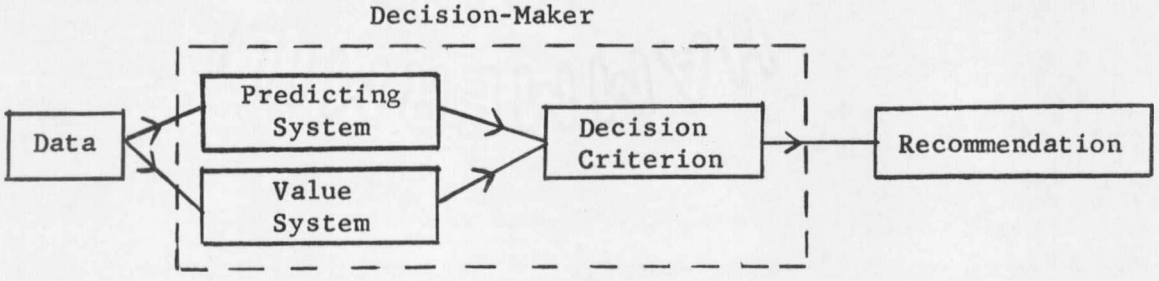
DECISION-MAKING AND CROP INSURANCE

Large-scale participation in the crop insurance program is vital to the success of the program. Successful selling methods are vital to developing large-scale participation. And successful selling methods require an understanding of decision theory and the decision-making processes of farmers. A discussion of decision theory provides a transition from the theory of insurance and the history of the Federal crop insurance program to the discussion of the more specific crop insurance problems, such as coverage and premium levels, merit rating, and meeting the changes in agriculture.

Decision Theory

The General Theory

Decision theory is the intellectual tool for scientific decision-making. It provides a process by which data from past records and observations can be fed into a predicting system and into a value system. The predicting system provides a list of possible outcomes for alternative actions, with a probability for each outcome. The value system provides a second quantity, the desirability associated with each outcome. Finally a decision criterion is applied whereby a recommended course of action is obtained. This process between the data and the recommendation, Bross calls the Decision-Maker. 1/ He illustrates it with the following diagram:



1/ Bross, Irwin, D. J., Design for Decision, MacMillan, New York, 1953, page 28.

For an extremely simple example of the application of the Decision-Maker, assume the situation where an individual has a mutually exclusive choice between two alternatives: Alternative A, to buy insurance on his home, or alternative B, not to buy insurance. He is a very scientific individual, to the extent that he has obtained some data on similar situations over a period of years and finds that he can associate four a priori discrete probabilities with alternative A, assuming that he is planning for 20 years ahead: (1) There is one chance out of 100 that he will have a complete loss; (2) there are two chances out of 100 that he will have a 25 percent loss; (3) there are 10 chances out of 100 that he will have a 10 percent loss; and (4) there is finally 87 chances out of 100 that he will have no loss. 2/

In this particular example, his outcome probabilities for alternative B need be no different than for alternative A, since his choice would not necessarily have any effect on the outcomes. (In the real world, if he is a poor moral risk, his choice may have some effect on the outcome.)

The second step in the Decision-Maker is for him to assign values to the outcomes, derived from his value system: Assume that he is considering insuring the full value of the house and contents at $10,000, and that the cost is $100 per year. He's not very good at figuring interest, so he chooses to ignore it, at least for the time being. The first part of the Decision-Maker, then, will look like the following, derived from his predicting system and his value system:

2/ In technical decision-theory terms, this example is the no-data problem, where the states of nature are the a priori probabilities, and there are only two strategies, to insure or not insure. It should be recognized that the example illustrates the simplest case. It is apparent that the situation becomes considerably more complicated if the individual is granted the choice of different insurance levels at different costs. These complications are compounded if the states of nature are related to a posteriori observations, resulting in a large number of possible strategies among which a choice is to be made.

Alternatives	Outcomes	Probabilities	Loss-Costs 3/
A	1 - 100% Loss	.01	$ 2,000
	2 - 50% Loss	.02	2,000
	3 - 10% Loss	.10	2,000
	4 - No Loss	.87	2,000
B	1 - 100% Loss	.01	$10,000
	2 - 50% Loss	.02	5,000
	3 - 10% Loss	.10	1,000
	4 - No Loss	.87	00

The next step in the Decision-Maker is to set up a Decision Criterion to apply to the evaluated outcomes of the two alternatives, by which he can arrive at a recommendation or action decision. He might choose as a criterion (by use of a sub-Decision-Maker?) the alternative with the lowest loss-cost expectation:

Outcomes	Probabilities	Loss-costs 4/	Loss-cost Expectations 4/
A-1	.01	$ 2,000	$ 20
-2	.02	2,000	40
-3	.10	2,000	200
-4	.87	2,000	1,740
20-Year Total Expected Loss, Alternative A			$2,000
B-1	.01	$10,000	$ 100
-2	.02	5,000	100
-3	.10	1,000	100
-4	.87	00	00
20-Year Total Expected Loss, Alternative B			$ 300

Ignoring interest, alternative B has the lowest loss-cost expectancy at $15 per year, as compared with $100 per year for alternative A.

However, his Decision Criterion may be more complicated, and usually is. He may make a part of it the qualification that peace of mind is worth at least $100 per year, under which condition his choice would be to buy the insurance.

3/ Loss-costs of alternative A in each case will be his premium payment, since his fire loss is indemnified by insurance.

4/ Ibid., page 88.

He may be in a financial position where he can stand a complete loss, and decide to choose the alternative with the lowest most-probable loss-cost, in which case he would decide not to buy any insurance.

If he were in a financial situation where he would seriously jeopardize his family's future if he lost his home to fire without any insurance, there would be no point in using the Decision-Maker (unless it relieved his mind to know a little more about what insurance costs him, taking account of loss probabilities). He would buy the insurance.

There are numerous other ways in which a Decision Criterion could be set up. The main point of this example is that it illustrates the systematic approach to decision-making in the face of uncertainty. The Decision-Maker has certain short-comings: It lacks exactness because the predicted probabilities are based on past history, evaluations of outcomes are prone to be subjective, and the criteria for decision require further decision analysis. The machine does not provide absolute answers; in the insurance example, it does not provide any answers as to how much better one alternative is than another, nor does it give much information as to how much insurance protection to buy.

However, the Decision-Maker has the big advantage of being applicable to the real world. It provides a system where no system previously existed. The system is neither based on absolute values, nor does it provide absolute values. Instead, it orders probabilities and values. In the example above, it is not as important that the probability of complete loss is .01 as it is that the probability of no loss in 20 years is many times as probable as a complete loss. It is not as important that the expected loss-cost with insurance is $100 per year as compared with $15 per year without it, as it is that there is only $85 per year difference, which may not be worth worrying about as compared with the peace of mind obtained.

The Decision-Maker is not a panacea for making decisions. Generally, individuals such as farmers could not be expected to use the system, especially as a formal model, in most of their decisions. Assuming that

this is the case, the system is still of considerable value in providing a thought process or an intellectual tool, as a systematic approach where none was used before. In many cases, the system is used subconsciously--the individual is not aware of its use. Bross sums up the place of the Decision-Maker in practical decision-making:

> When I say that Statistical Decision can play a role in personal decisions I do not mean that everyone will have to take courses in higher mathematics before he can decide whether or not to go to the movies. Very few everyday decisions would have sufficiently wide differences in the consequences of the possible actions to make it worth while to expend the time and energy necessary to construct a formal Decision-Maker. However, I do think that the principles which underlie the Decision-Maker can also be used, informally, to arrive at effective choices of actions to be taken in everyday situations. In fact, I think that most people with common sense have already used many of the principles in making their decisions. All that the statisticians have done is to borrow these notions and dress them up in the symbolic language. 5/

Decision Theory and All-risk Crop Insurance

Why is it necessary to understand the general decision theory model, as a contribution to the improvement of the Federal crop insurance program? First, the farmer is a decision maker. Farm management books usually begin with a definition of farm management that emphasizes decision-making as the center of good management; for example, Castle and Becker:

> Successful farming, if we measure success in terms of profitability, is determined by the farmer's managerial ability. Used in this sense, farm management is concerned with the decisions that affect the profitability of the farm business. 6/

They list the usual five steps in the decision-making process, and later, in their eighth chapter, on risk and uncertainty, they present the simple decision-making model, which corresponds to Bross' Decision-Maker.

Second: The insurance salesman is in a position to furnish the data that is fed into the Decision-Maker. This data provides the basis for

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5/ Ibid., page 256.

6/ Castle, Emery N., and Becker, Manning H., Farm Business Management, MacMillan, New York, 1962, page 3.

prediction of probabilities and contributes to the evaluation of outcomes for the Value System. The salesman is also in a position to help the prospective insured become aware of the use of a Decision-Maker, and to set up criteria for decision. For example, the farmer usually has a reasonably accurate idea of his yields, and frequency of his good and bad years in the past. The salesman probably has supplemental data on yield trends, rainfall records, and county averages with which the farmer can check his own data. The salesman can help him to fit the data into a probability framework. He can also assist the farmer in fitting his yields and production costs into a framework that will better evaluate the farmer's possible financial loss under given yield conditions. A part of this evaluation is the cost of the insurance itself. Either by a systematic thought process, or actually writing down the Decision-Maker, the farmer, with the aid of the salesman, can derive a set of evaluated alternatives upon which he can base his decision to buy insurance and how much.

Third: At this point the salesman can assist the farmer in developing a set of decision criteria with which to make the choice between the evaluated alternatives. Here he can call the farmer's attention to the points he should consider in setting his criteria: His financial situation or liquidity position; alternative methods of meeting uncertainty, and how these alternatives will affect his plans and costs; and any other individual situations that would affect his decision criteria.

Insurance-Evaluation Model

A critical problem that must be solved by the farmer is his evaluation of insurance benefits and costs. The salesman enhances his success if he can contribute to the solution of this problem, which is a vital part of the Decision-Maker. The evaluation of a farmer's action alternatives in buying insurance depends to a large degree upon the relationship between two functions:

The net insurance premium = I + A + S

The buyer's evaluation of the utility of insurance to himself = $L + U \pm X \pm Z$ where:

I: The actuarial determination of indemnities expected, including reserves for unexpected perils.

A: Administrative costs, including services, claim adjustment epxenses, and normal profits.

S: Sales or acquisition costs.

L: The farmer's expected loss.

U: The farmer's utility derived from protection or from converting the uncertainty of loss to a certain expense (including better planning, better sleep, concern with his liquidity situation, etc.).

X: Margin of extra cost he is willing to accept because of his inability to accurately assess his expected loss (this could be a negative factor depending upon his attitude).

Z: Other factors such as his desire to gamble, his aversion to government programs, his concern with his neighbor's situation, etc. (this also could be either positive or negative).

The first condition of the decision model is that a person will not consider buying insurance if the insurance premium is greater than the buyer's evaluation of his utility received, or:

(1) $I + A + S \geq L + U \pm X \pm Z$

But the buyer will not buy insurance, either, if the marginal return (or utility) of insurance (MRi) per marginal cost (MCi) is not at least as large as the marginal return (MRo) from an alternative expenditure per marginal cost (MCo), which becomes the second condition for the decision model:

(2) $\frac{MRi}{MCi} \geq \frac{MRo}{MCo}$

Combining the first condition with the second, since MCi = I + A + S, and MRi = $L + U \pm X \pm Z$, the condition for the decision model becomes:

(3) $\frac{L + U \pm X \pm Z}{I + A + S} \geq \frac{MRo}{MCo} \geq 1$

Moving to the specific case of the farmer buying Federal crop insurance, the assumption is made that the Z has been eliminated or minimized, and

therefore that he is willing to formulate his decision upon economic considerations. Also, the A and the S are eliminated, since they are subsidized by the Government. Therefore the farmer's condition for purchase becomes:

$$(4) \quad \frac{L + U \pm X}{I} \geq \frac{MRo}{MCo} \geq 1$$

One final condition needs to be stated: The coverage upon which the premium (I) is based is assumed to be equal to the coverage upon which the buyer's loss expectancy and utility evaluation (L and U) are based. Therefore, coverage does not need to appear in the above condition formula. For instance, if the coverage is inadequate for the farmer's needs, the inadequacy will be reflected in U, with the relation between L and I remaining relatively constant.

The model condition (3) above can be illustrated by the following diagrams, representing (A) the "bundle" of factors making up the insurance premium; (B) the bundle making up the prospective buyer's evaluation of the insurance; (C) the bundle representing other wants of the buyer; and (D) the bundle representing the marginal costs of these wants:

(A)	(B)	(C)	(D)
S: sales or acquisition costs A: administrative costs I: expected losses from perils insured plus reserves	Z: other factors U: utility derived from protection, etc. X: margin of extra cost L: farmer's expected loss from perils insured against	The want or bundle of wants other than insurance with highest marginal utility per dollar expended	The marginal cost of C

One part of condition 3 is that the size of bundle A is equal to or less than the size of bundle B. If this first part of the condition is met, then the second part is that the ratio of bundle (B) to bundle (A) is equal to or greater than the ratio of bundle (C) to bundle (D); i.e., that

the utility per dollar spent on insurance is equal to or greater than the highest utility received from the last dollar spent on any other commodity or service.

The differences between condition (3) and (4) is that S and A are eliminated from bundle (A) (FCI situation) and Z is eliminated from bundle (B), leaving the bundles as follows:

(A)	(B)	(C)	(D)
I: expected losses from perils insured against, plus reserves	U: utility derived from protection, etc. X: margin of extra cost L: Farmer's expected losses from perils insured against	Wants other than insurance with highest marginal utility per dollar expended	The cost of (C)

Note that there are two factors affecting the insurance premiums, which are omitted in the model: Income tax effect on the net premium paid, and experience and size credits. The income tax deductions depend upon individual situations, and in effect lower the net premium paid. If a farmer pays an income tax at least one-half of the years, he can figure that he can reduce his premium by at least half the average income-tax percentage. If his decision is considerably influenced by his aversion to paying a premium in a year when he receives no indemnity, then the reduction allowance in his premium because of taxes would be even more important.

Experience credits do not affect the decision-making of the farmer who is contemplating buying insurance for the first time, nor one who is continuing to buy while he is building an experience base. Experience and size credits should be considered as bringing I and L closer to equality.

Both the income-tax and experience-rate factors are therefore to be considered as tools of the salesman or problem-solver, to be used along with the decision model.

Using the Model

Much has been contributed to throw light on farmer decision processes. Ideas and hypotheses concerning farmers' reactions under uncertainty are gathered together in the Proceedings of Research Conference on Risk and Uncertainty, the results of a Great Plains Council Meeting at Bozeman, Montana, in 1953. Pertinent to this present study is Haver's hypothesis and proposal:

> The proposed study provides the hypothesis, stated briefly, that there is a zone of indifference within which changes or decisions are not made. A rather "strong" stimulus or jolt is necessary to give rise to a decision-making situation. The existence and nature of the indifference zone under various conditions of risk and uncertainty or conditions with respect to size of business, equity position, family situations, etc., need investigation.
>
> As a necessary step decisions should be classified according to type or manner in which decisions are made. Some decistions might well be made by a flip of a coin; another decision should be made only after additional information is acquired, etc. Also, a decision may hinge on a prime criterion or on two or more lesser criteria. The processes farmers use in arriving at decisions provide a basis for determining what information research can provide to assist in making decisions. 7/

If the problem-solver can proceed beyond the point of bias, custom, or habit as the farmer's basis of decision-making, he has the opportunity to use the decision model by which he can demonstrate the problem, or can produce the "jolt" that will move the decision-maker to a decision-making situation.

Condition (4) is repeated for convenience:

$$(4) \qquad \frac{L \pm U \pm X}{I} \geq \frac{MRo}{MCo} \geq 1$$

7/ Haver, C. B., "A proposal on Farm Decision-Making," Proceedings of Research Conference on Risk and Uncertainty in Agriculture, Bulletin 400, Agricultural Experiment Station, North Dakota Agricultural College, Fargo, 1955.

The FCIC's loss expectancy (I) can be taken as given, the quoted premium based on its actuarial determination for a given insurance group. The salesman's function then, is to analyze with the farmer, his evaluation of the (B) bundle (L + U $\pm$ X), as compared with the (A) bundle, hoping that the ratio is greater than the ratio of (C) to (D), or MRo to MCo.

A farmer with good records may be able to determine fairly accurately what his loss expectancy L may be. In a low-risk area, there is a high probability that his FCI-loss expectancy, especially based upon the past 25 years, may be nil, especially from drouth and perils other than hail. Even his expected FCI-loss from hail may be nil, based on past records, either because his unit is widely dispersed, or losses have not been severe enough to have lowered the total unit yield to a level that would have been indemnified under the FCI coverage. In this case, the difference between I and L would be extreme, particularly if the insured group included some higher-risk areas. The salesman's problem is to build the (B) bundle of utility by stressing the idea of the occurrence of an unknown peril (that it is always possible that things which have not occurred in the past <u>can</u> occur in the future); and the utility from protection, better planning, and safety of solvency.

More important for this situation is the analysis of the farmer's premium-cost. The low-risk farmer is more justified in reducing his premium by his average income tax percentage at the margin, because he is likely to have a higher proportion of tax-paying years. Further, and possibly even more important, is the fact that a low-risk farmer can be nearly assured of developing an experience credit which will reduce his premium by as much as 50 percent. As has happened in some of the lowest-risk areas, (I) has been reduced to the point where both (I) and (L) are so small that the difference between them is of little concern, and the size of (U) and (X) have thus become relatively much more significant.

If the good record keeper is located in a high-risk area, the difference between (I) and (L) is not likely to appear so pronounced (at least relative to total I). He will likely be more concerned with his management abilities as compared with his neighbor's. Because he does have a high loss expectancy, he will probably recognize and accept a higher value of (X). His (U) will likewise be considerably higher than for the low-risk operator. Though his expectancy of loss-free years will not be as high as for the low-risk operator, his potential for premium-saving will be just as high if not higher, as a result of good management. Since his premiums are considerably higher, it takes less loss-free years (under present formulas) to build an experience credit. Also the experience-credit percentage is applied to a much higher premium charge. The higher-risk operator may not be as interested as the low-risk operator in the reduction of premium due to income-tax deduction, since the former will likely have a smaller proportion of years when he will be paying income taxes.

The principal difference between the good record-keeper and the poor in their insurance-decision-making process would be in the emphasis they would place on their own individual loss expectancy. The farmer with less long-time records would likely be more concerned with his situation relative to his neighbors' current crop yields. If so, the salesman's emphasis on experience credits should be even stronger than for the good record-keeper. The poor record-keeper's (X) value will probably be considerably less, because he knows less about his actual loss expectancy. On the other hand, his L would likely be more nearly equal to I. If he knows less about his business, he will probably be below, rather than above average in management ability. This factor should tend to make his (U) value higher than for the above-average operator because he should be more uncertain of the future.

Special note should again be made of the fact that administration costs of FCI are not included in the premiums, but are subsidized by the government. If they were made a part of the (A) bundle of insurance costs,

the U and X values in the (B) bundle of farmers' utility must be increased accordingly in order to retain the same ratio. If the FCIC is called upon to assume the costs of administration (as discussed in Chapter 9), the addition of A and S to the (A) bundle will present a critical problem to the salesman problem-solver: He must be more ingenious than ever at analyzing the U and X values and helping the farmer to evaluate them in his decision-making process.

Some Observations

General decision theory provides a scientific tool for decision-making, the Decision-Maker. A model has been developed for evaluating and comparing the benefits and costs of all-risk crop insurance. Another step in understanding decision-making, and likewise improving communication between the insured and personnel involved in the Federal crop insurance program, is to analyze the nature of farmers' decision-making processes, derived from some observations.

General Observations

Some farmers make decisions on the basis of just a hunch or snap judgment, while at the other extreme are those who are scientific in their decision-making. The same farmer may at one time be very unscientific in making a decision, and then make another decision only after careful thought and analysis (don't we all?).

A cash-grain farmer located on the west side of the Montana Triangle was asked why he didn't participate in the crop insurance program. His answer was that two of his neighbors had been in the program for several years and collected for losses every year; he believes he hasn't had any losses that would have been paid if he had taken insurance and he isn't about to help pay for his neighbor's bad management. Upon further questioning, to determine if he had used any marginal analysis or any other scientific approach to making his decision, it was found that the above was apparently his only consideration in deciding not to buy crop insurance. The FCIC director in the area thought that very likely this farmer was uninformed, poorly informed, or even misinformed as to just

how much losses had been paid to his neighbors.

A survey of the Montana FCIC files reveals that there are many variations in participation history among those who are or have been insured. There are those operators, both large and small, who have participated in the program since its inception, or at least since 1948. Some of them have received practically no indemnities and some at the other extreme have received several sizable indemnities. There appears to be no obvious pattern. There are some who have been in and out of the program several times. Some of these have accumulated experience credits which they have given up when they dropped out. There are those who have been paid for large losses, and then dropped out of the program. Again there appears to be no obvious pattern.

One operator with a 400-acre wheat allotment has been in the program since its inception, and during that time has received total indemnities of less than $500. He feels that his size and experience credits have lowered his premium to the point where he can't afford to drop his insurance. His neighbor has been in and out of the program several times, and probably would not have received any more indemnities had he stayed in throughout the history of the program; he again insured his crop in 1964 at the full rate with no experience credits, at which time he indicated that he was going to stay in the program.

Some operators in the Northwest Triangle of Montana, even after three consecutive years of losses, continue to stay out of the program, while some of their neighbors, with large and successful operations, have purchased Federal crop insurance for the first time. Northeastern Montana farmers have experienced two consecutive bumper crops, yet participation in the crop insurance program remains high and expanding. Southeastern Chouteau County has had no crop failures from drouth in recent years, yet participation continues at a high level. 8/

Studies that have been based on farmer surveys indicate that the major reason given for non-participation is that the premiums are too high

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8/ From information obtained from personnel in Montana State FCIC office.

and coverage too low. 9/ This reason appears to be of little value to an analysis of decision-making because it implies a relationship without providing a standard of comparison: The premium is too high and coverage is too low relative to what? In deciding whether or not the coverage is too low and the premium to high, a farmer is basing his decisions on many different things: He probably has in mind that the premium is too high relative to the coverage. Or he may feel that the premium is too high relative to the coverage and any peace of mind he derives from it; or to what his neighbor in the next county is paying; or to his loss expectancy; or to how much he is willing to gamble; or to the sort of a bargain that allows him to accept a government program contrary to his anti-government conviction; or to how much return he can obtain from the premium money if spent elsewhere. He may feel that the coverage is too low relative to his costs; or to what he needs for family living above cost; or to the coverage he gets from hail insurance (taking little account of the fact that hail insurance covers only one peril); or relative to the premium; or to the coverage his neighbor obtains on poorer land under poorer management; or to his own average yield.

An Analysis of the Observations

The first farmer who objects to what he believes to be excessive indemnities collected by his neighbors bases his decision upon whether he feels the benefits he can receive from crop insurance are greater than the disutility of accepting the cost of their poor management, and whether experience credits will sufficiently account for the difference.

The farmer who has a particular aversion to government programs may base his decision, consciously or unconsciously, upon whether he feels

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9/ Bray, Norman, Performance of Federal Crop Insurance in Western Nebraska, Unpublished Thesis, University of Neb., 1963, page 97;
Starr, Gayle David, The Federal Crop Insurance Program in Eastern Nebraska--Saunders County, A Case Study, Unpublished Thesis, University of Nebraska, 1963, page 47;
Moore, Jerry M., Economic Analysis of Crop Insurance in Eastern Colorado, Unpublished Thesis, Colorado State University, 1964, page 46.

that the benefits from crop insurance are greater than the disutility of making a decision counter to his conviction.

The excellent operator who has almost nil drouth-loss expectancy, but continues to carry both all-risk and hail insurance, is probably influenced by such factors as: He may be a "cooperator," one who tends to support programs he feels are generally godd for agriculture, especially if his marginal cost for cooperating is relatively low; he is probably reluctant to give up a good experience credit, which also makes his cost relatively low, compared with his other farm costs. (The farmer of this type in Chouteau County, described above, is paying a premium of about $240 per year for an insurance coverage of $11,700 on a 400-acre wheat allotment.) He may also feel an awareness of the possibility of complete loss from hail and unknown perils, against which he can protect himself at a relatively small cost with Federal crop insurance.

The farmer who takes a scientific economic approach would tend to arrive at his decision through the process of the Decision-Maker and the insurance-evaluation model. He could be expected to analyze past records, derive some sense of probabilities, know something about his potential losses and farm costs, and, at least with the aid of a good salesman, arrive at a decision somewhat systematically. He probably gives more attention to whether his loss-cost expectancy is appreciably below the group average; whether he is financially able to withstand large and consecutive crop losses; to what extent he can use other methods of meeting uncertainty to advantage; and what relative value he can place upon peace-of-mind, as compared to the cost of insurance.

The insurance model includes a symbol U, which represents the farmer's utility derived from "protection" or from converting the uncertainty from lose to a certain expense (including better planning, better sleep, concern with financial liquidity, etc.). Here the term "protection" is used to refer to those benefits from insurance above the individual's loss expectancy arising out of perils coverd. A large proportion of buyers of all types of insurance apparently are influenced by the value of this

"protection" as part of the insurance package. As evidence, a huge volume of fire and casualty insurance is purchased in the United States whereby the total premiums collected are at least 30 percent in excess of indemnities paid. 10/ This represents a willingness of insureds to pay substantially more for insurance than their expected loss cost.

Problem-Solving and Crop Insurance Sales

Whether to buy crop insurance is but one of the many decision problems confronted by the farmer. This places the FCIC in the position of the other problem-solvers, such as the machinery dealers, fuel dealers, feed retailers, grain and livestock buyers, and all the rest. Therefore, there is little reason for the FCIC to approach its sales and participation problems any differently than the other farm problem-solvers.

The usual procedure is to seek out the farmer's problem, and to figure out ways to help him to solve it. In most cases, the farmer may not be conscious of his problem, or perhaps he hasn't isolated it. For instance, because of the nature of his daily work, the farmer may not be aware of possibilities of saving labor and fuel, and of improvements in the work accomplished if he traded the old tractor for a new one. He may not be aware of a new breakthrough in formulating livestock feed, or of results from a new weed spray or fertilizer. He may not be aware of the fact that at a particular time feeder buyers are becoming active and paying considerably over the published markets, or the elevators are paying 10 cents over the market for certain grades of wheat.

Take, as an example, the first farmer, who is concerned about his two neighbors. He may have some problems of which he is not aware. The first step for the crop-insurance problem-solver is to seek out the problem which he can help to solve. It is impossible to communicate with the farmer concerning his own problem before resolving his feelings.

10/ Best, Alfred M. and Co., Best's Insurance Guide With Key Ratings, New York, 1964. From general analysis of company premiums collected and loss expenses.

concerning the two neighbors; does he have the facts: (1) Have the two neighbors, in fact, collected almost every year on their insurance? (2) Has the farmer himself, in fact, had no losses that would have been indemnified if he had been insured? (3) Is he aware of the fact that experience credits can go a long way toward making allowance for the differences in management? (4) Is he aware of the fact that FCIC underwriting methods are continually eliminating insureds who, because of continued poor management, collect an abnormal share of indemnities? Since the concern with the two neighbors is critical in this individual's decision-making process, this concern must be resolved before delving deeper into his insurance problem.

The next step is to determine how well informed he is regarding Federal crop insurance, and whether he has any deep-seated aversions to Federal programs. An approach to obtaining this information may be through arousing interest in the solution of uncertainty problems. This in turn can lead to an analysis of the farmer's need for insurance. There is no reason to believe that every single farmer needs insurance. This particular farmer may not need insurance. If this appears to be the case, this should be the end of this interview. After all, a wise implement dealer would not try to sell a beet digger to a fermer who had no sugar beets.

Assuming the need is established, the next step is to impress the farmer with the nature of his problem, and his alternatives in solving it. This is the point at which per-crop-acre costs can be combined with yield probabilities and alternatives of meeting the uncertainty situations. All of these fit into the decision models.

CHAPTER V

COVERAGE LEVELS

A high percentage of participation has been shown to be important to the success of an insurance program. The Federal crop insurance program is no exception. The main purpose of the GP-8 regional study is to find ways that the program can be improved, particularly how participation can be increased. It was noted in the previous chapter that the main reason interviewed farmers gave for non-participation was that premiums are too high and coverage is too low. 1/ The problem is relating the coverage to needs and relating the premiums to the risk. The needs for all-risk crop insurance are most often expressed in terms of protecting the "investment in the crop." Sales efforts also are directed more and more toward this goal.

Investment in the Crop

"Investment in the crop" has received considerable attention in development of the Federal crop insurance program. Investment was often mentioned as a critical and necessary coverage limitation during the debates in Congress. 2/ It was considered by Halcrow to be a definition of "insurable interest:"

> In some other instances the insurable interest of the farmer has been defined as his investment in the growing crop. In some other cases attempts have been made to reduce the carrier's liability by restricting the yield coverage to a level not exceeding the average investment in the crop at time of abandonment of the crop. 3/

In a section titled "All-Risk Crop Insurance and Resource Utilization" he refers to investment in the crop when he relates farmers' reactions to expected yields and insurance coverage:

1/ vide., footnote (9), Chapter IV.

2/ See "Review of the Congressional Record," Chapter III.

3/ Halcrow, Harold G., Theory of Crop Insurance, University of Chicago, 1948, pp. 30, 31.

> If the discounted value of the insured yield is at least equal to the farmer's investment in the crop the farmer would avoid loss under any condition. 4/

Though Halcrow attached importance to "investment in the crop" as a coverage limit and as a measure of insurable interest, he did not define the term.

Clendenin was one of few authors in the early crop insurance literature who set up a cost analysis and compared it with coverage. He was interested in measuring the adequacy of insuring 75 percent of the normal yield. His cost classification was labeled "Out-of-Pocket Costs of Producing Wheat on Debt-Free Farms of Typical Size and Fertility," and included the following items:

Hired labor ("Two-thirds of the farm labor is assumed supplied by the operator and his family in the North Dakota illustration, one-half in the other cases. Only hired labor is shown in costs, operator's labor and return on investment must be compensated from excess of selling price over costs.")

Horse work

Contract threshing

Commercial fertilizer

Sacks and Twine

Seed, etc.

Machinery ("Depreciation, insurance, and maintenance costs on machinery, fences, and barns are included in proper ratio.")

Miscellaneous

Taxes

4/ Ibid., page 54. Halcrow also quotes the 1947 amendment to the Federal Crop Insurance Act: ". . . if 75 per centum of the average yield on the insured farm represents generally more protection than the investment in the crop in any area, taking into consideration recognized farming practices, the Board shall reduce such maximum percentage so as more nearly to reflect the investment in the crop in such area. . ."

Clendenin apparently excluded interest and land costs from his estimate of out-of-pocket costs, but included harvest expenses. 5/

The writers and speakers on all-risk crop insurance had in mind some specific cost concept. The question is, which of the following cost items are included, and which are omitted in the term "investment in the crop":

Preharvest expenses: These include not only all variable costs incurred in summerfallowing, and preparations for and planting of the crop, spraying, and fertilizing, but also fixed costs such as insurance and machinery ownership. All costs (including those listed under "special costs") incurred each year regardless of crop conditions should be included in this category.

Harvest expenses: These include all costs that are obviated by complete crop failure. It should be remembered, however, that these costs are incurred on the harvestable acreage in case of partial loss.

Special expenses: These include large special items such as all-risk crop insurance and hail insurance (optional), taxes (deferrable), interest on land and buildings (no current cash outlay unless there are fixed debt payments) and family-living allowance.

The approach to the problem in this study is to select the expense items from some typical Montana farm budgets and reclassify them according to the above categories. These are used to analyze the results obtained by assuming various definitions of "investment in the crop." Also, the reclassified budgets can be used in analyzing and solving other crop-insurance problems. For example, in selling crop insurance, some of the Federal crop insurance salesmen use the "investment" approach; that is, they assist the prospective insured in determining his "investment" in the

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5/ Clendenin, J. C., "Federal Crop Insurance in Operation," Wheat Studies of the Feed Research Institutes, Stanford University, Vol. XVIII, No. 6, March, 1942, page 240.

crop so that he can visualize his potential loss and therefore be better able to make the best choice of coverage level. From the following tables an expense guide can be developed to serve as an aid to both the salesman and farmer during a sales approach.

The sources of costs for these expense tables are LeRoy Rude's cash-grain farm budgets for Northeastern, North Central and South Central Montana, for three sizes of farms in each area. 6/ (These three areas, outlined in Figure 1 will henceforth be called "cash-grain areas.") Only the wheat-and-barley enterprise combination is selected, assuming that variations can be made to adjust to other types of enterprise combinations as the need arises.

Though these data are derived from Montana farm studies, the general relationships which the tables illustrate are adaptable to the other dryland wheat areas of the United States. The conclusions drawn illustrate the importance of being specific when referring to "investment in the crop," whether the crop be wheat, corn, tobacco, cotton, fruit, or vegetables.

Classification and Definitions of Expenses

Tables VIIA, B, and C itemize the expense budgets for the three sizes of cash-grain enterprises, 830, 1,200 and 1,700 acres. Cost subdivisions are explained as follows, using major categories defined above:

Preharvest expenses

Hired labor: This item depends upon the size of farm, the size, age, and sex composition of the family, and how the family prefers to spend its income. Hired labor for the 830-acre farm is omitted, assuming that there is a member of the family besides the owner who can drive a truck during harvest.

It being a reasonable assumption that the family labor on the 830-acre farm is fully employed, labor hours in excess of

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6/ Rude, LeRoy C., Land Use Alternatives for Dryland Cash Grain Operators (Northeastern Montana, North Central Montana, and South Central Montana) Dept. of Ag. Econ. and Rural Soc., Montana Agr. Exp. Sta., Bozeman, Mont., in cooperation with U.S.D.A., A.R.S., F.E.R., Div. 1959.

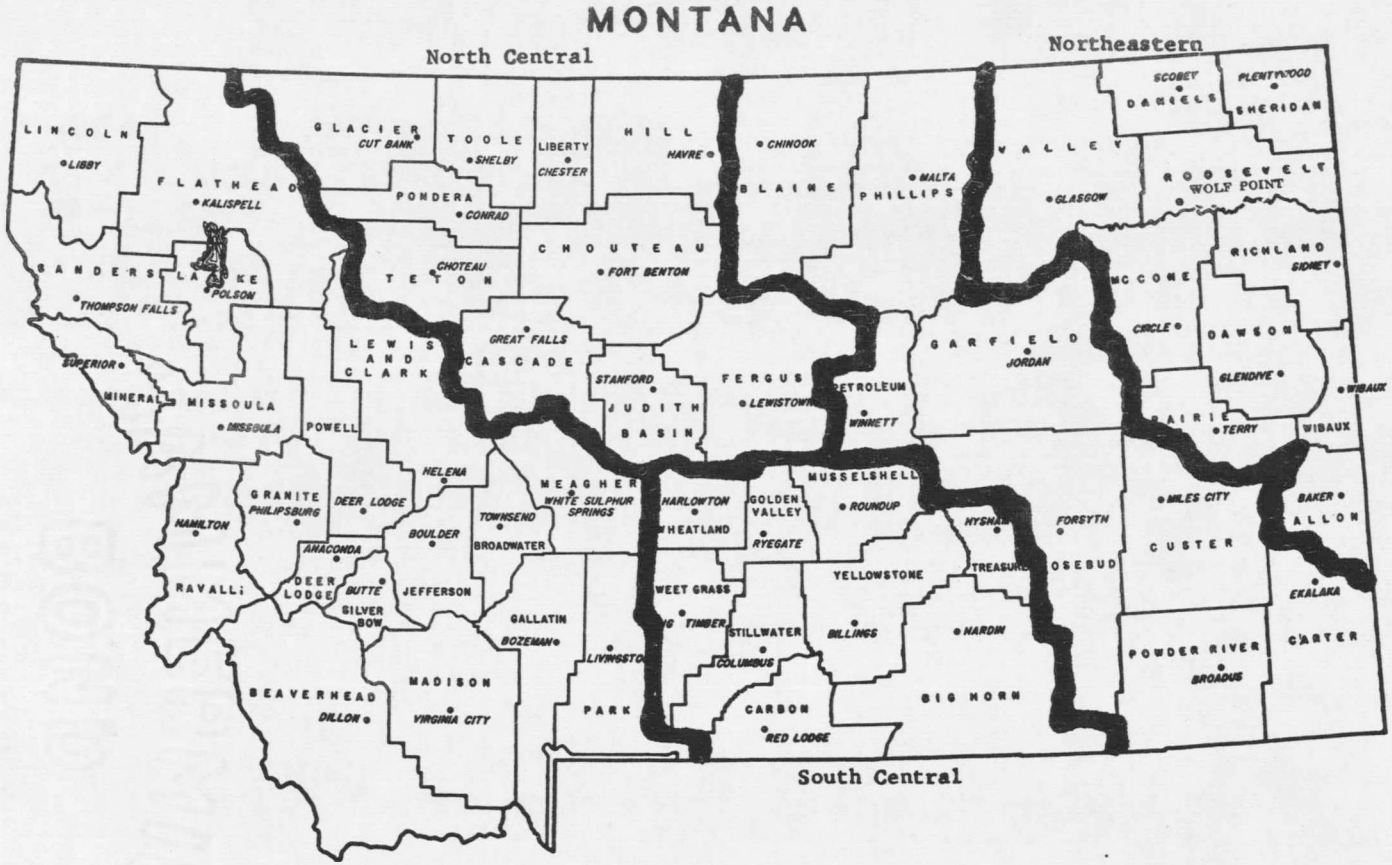

Figure 1. Montana "Cash Grain Areas".

those charged to the 830-acre farm are considered as hired labor, on the 1,200 and 1,700 acre farms. Table II is a summary of total hours of labor and hours of hired labor, estimated according to the above method.

Wages applied to the hours of hired labor are $1.00 per hour, based on wages earned at farm work in the Western region in 1959. 7/ Wages earned were $8.85 per day worked, which, assuming an 8-hour day indicates that $1.00 per hour is a reasonable assumption.

Fuel, oil and repairs: Includes all expense, listed in Table 2 of Appendix of Rude's Reports except for combine and 1/3 of grease costs.

Seed and treatment: Treatment of seed is included in variable expenses in Rude's budgets, but seed was included as a deduction from an income item. However, for this report seed cost is more appropriately included as a pre-harvest expense item, and is calculated by multiplying planted acreage X amount seeded per acre X price per Rude's income budget.

Motor vehicles: Includes all expense, except truck mileage charged to harvest expense at 6¢ per mile. It is assumed that the portion of the pickup and car mileage used during harvest will balance with the portion of the truck mileage used in preharvest.

Insurance: All insurance (except all-risk crop and hail) is charged to pre-harvest expense because any that is obviated by crop failure is insignificant for purposes of this report.

Machinery ownership: Includes all depreciation and interest on equipment because investments in machinery cannot normally be varied according to success of the crop.

7/ Ruttan, Vernon W., "The Human Resource Problem in American Agriculture," Farming, Farmers, and Markets for Farm Goods, Committee for Economic Development, Supplementary Paper No. 15, Nov. 1962, page 87.

TABLE II. TOTAL AND HIRED LABOR HOURS FOR CASH GRAIN FARMS OF 830, 1200, AND 1700 ACRES, MONTANA CASH-GRAIN AREAS. *

Area and Size of Farm	Total Labor Hours			Hired Labor Hours[a/]		
	Combining	Other	Total	Combining	Other	Total
	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.
Northeast						
830-acre	208	472	680	---	---	---
1200-acre	258	641	899	50	169	219
1700-acre	420	894	1314	212	422	634
North Central						
830-acre	180	435	615	---	---	---
1200-acre	232	572	804	52	137	189
1700-acre	372	816	1188	192	381	573
South Central						
830-acre	206	465	671	---	---	---
1200-acre	232	754	986	26	289	315
1700-acre b/	232	927	1159	26	462	488

* Source: Rude, LeRoy C., Land Use Alternatives for Dryland Cash Grain Operators, (Northeastern, North Central, and South Central Montana) Dept. of Ag. Ec. and Rural Soc., Mont. Ag. Expt. Sta., Bozeman, Mont. in cooperation with U.S.D.A., A.R.S., F.E.R. Div., 1959. Table 2 of appendixes.

a/ Hired labor hours estimated by deducting hours for 830-acre farm from total hours for larger farms, per explanation in text.

b/ Combining hours are same as for 1200-acre farm because in Rude's study a combination of one combine plus custom harvesting was employed on 1700-acre farm rather than 2 combines as for the other 2 areas.

Miscellaneous costs: This is an allowance for small expense items which were unclassified.

Harvest expenses

Hired labor: (See explanation under Preharvest expenses above)

Fuel, oil and repairs: Includes only expenses for the combine and 1/3 of grease.

Motor vehicles: Includes all of variable truck expense at 6¢ per mile. (See footnotes on Tables VIIA, B and C.)

Custom combining: Rude allowed a certain number of manhours per combine for the harvest. Where it did not pay to own two combines, and one combine was not sufficient to complete the harvest in the allotted time, custom combining was charged at the rate of $3.50 per acre with an allowance of 4¢ per bushel for hauling.

Grain storage: This item was included in Rude's reports, based on 3.5¢ per bushel. It is an item that would be incurred, but characterized by extreme variability between farmers and also over time.

Miscellaneous costs: This is an allowance consistent with the same item in preharvest expenses.

Special expenses:

All-risk crop insurance: This is an optional expense, the cost depending upon acreage, coverage, rates, experience, and size credits. The amount selected is a "best estimate" of an average for each of the three cash grain areas, within the limits of precision required for this study and for purposes for which it may be used. The basic rate was chosen from Tables IIIA, and B, which list the coverages available, price-level choices, and premium rates in each rate area of each county in the cash-grain areas of Montana. The rate selected for cost purposes was the lowest if there were two areas, and the second lowest if three or more areas in a county.

A simple average of rates selected for each county in each area was calculated and applied to the acreage of each crop in Table IV, to arrive at a cost for all-risk barley and wheat crop insurance on each size farm in each cash-grain area. These are the costs entered in Tables VIIA, B, and C.

Crop-hail insurance: This is another optional expense, the cost of which depends upon acreage, value-per-acre coverage desired, and rates. Like all-risk crop insurance, only a "best estimate"

TABLE IIIA. MONTANA FEDERAL WHEAT-CROP INSURANCE, BUSHEL GUARANTEE, AND PREMIUM RATES PER ACRE FOR VARIOUS PRICE LEVEL CHOICES, 1964, COUNTIES IN MONTANA CASH-GRAIN AREAS. *

County	Area No.	Guarantee Per Acre	PRICES PER BUSHEL[a]				
			$1.25	$1.50	$1.75	$2.00	$2.25
			PREMIUM RATE PER ACRE				
		Bu.	Dol.	Dol.	Dol.	Dol.	Dol.
			Northeastern				
Daniels	1	8.0		1.70	1.90**	2.20	
Dawson	1	6.5		2.00	2.30	2.60	
	2	7.5		2.00	2.30**	2.60	
	3	8.5		2.00	2.30	2.60	
Fallon	1	6.5		1.70	1.90	2.20	
	2	8.0		1.70	1.90**	2.20	
McCone	1	7.0		2.10	2.50	2.80	
	2	8.5		2.00	2.30**	2.70	
Richland	1	9.0		1.80	2.10	2.40	
	2	8.0		1.80	2.10**	2.40	
Roosevelt	1	8.5		1.60	1.80**	2.10	
Sheridan	1	7.0		1.20	1.40	1.60	
	2	8.0		1.20	1.40**	1.60	
	3	9.5		1.50	1.70	2.00	
Valley	1	7.5		1.80	2.10	2.40	
	2	8.0		1.50	1.70	2.00	
	3	9.0		1.70	2.00**	2.20	
Wibaux	1	7.0		1.60	1.90	2.20	
	2	8.0		1.60	1.90**	2.20	
			North Central				
Cascade	1	11.0	1.00		1.50		1.90
	2	13.0	1.00		1.50**		1.90
Chouteau	1	9.0	.90		1.20		1.60
	2	10.0	.90		1.20		1.60
	3	11.0	.90		1.20**		1.60
	4	13.0	.90		1.20		1.60
Fergus	1	8.0	1.20		1.60		2.10
	2	10.0	1.20		1.60**		2.10
	3	11.5	1.10		1.50		1.90

See footnotes on following page.

TABLE IIIA. (Cont.) MONTANA FEDERAL WHEAT-CROP INSURANCE, BUSHEL GUARANTEE, AND PREMIUM RATES PER ACRE FOR VARIOUS PRICE LEVEL CHOICES, 1964, COUNTIES IN MONTANA CASH-GRAIN AREAS. *

County	Area No.	Guarantee Per Acre	PRICES PER BUSHEL[a/]				
			$1.25	$1.50	$1.75	$2.00	$2.25
			PREMIUM RATE PER ACRE				
		Bu.	Dol.	Dol.	Dol.	Dol.	Dol.
Glacier	1	9.0	1.30		1.80**		2.40
	2	11.0	1.60		2.30		2.90
Hill	1	7.0		1.90	2.30	2.60	
	2	9.0		1.90	2.30**	2.60	
Judith Basin	1	8.5	.80		1.20**		1.50
	2	10.0	1.00		1.40		1.80
Liberty	1	8.5		2.00	2.30**	2.60	
	2	10.0		2.10	2.50	2.80	
Pondera	1	12.0	1.10		1.50**		1.90
Teton	1	9.5	1.00		1.40**		1.80
	2	12.5	1.10		1.50		1.90
Toole	1	9.0	1.30		1.80**		2.40
	2	11.0	1.60		2.30		2.90
			South Central				
Big Horn	1	7.0	1.30		1.80		2.30
	2	10.0	1.30		1.80**		2.30
	3	12.0	1.30		1.80		2.30
Stillwater	1	8.0	1.00		1.30		1.70
	2	10.0	1.10		1.50**		2.00
	3	11.0	1.20		1.70		2.10
Yellowstone	1	12.0	1.30		1.90**		2.40

* Source: Montana--Wheat Crop Insurance--1964 and Succeeding Crop Years, (FCIC Rate Schedule).

a/ The premium rate chosen for Table IV is indicated (**).

TABLE IIIB. MONTANA FEDERAL BARLEY-CROP INSURANCE, BUSHEL GUARANTEE, AND PREMIUM RATES PER ACRE FOR VARIOUS PRICE LEVEL CHOICES, 1964, COUNTIES IN MONTANA CASH-GRAIN AREAS. *

County	Area No.	Guarantee Per Acre	PRICES PER BUSHEL[a/]		
			$0.60	$0.80	$1.00
			PREMIUM RATE PER ACRE		
		Bu.	Dol.	Dol.	Dol.
		Northeastern			
Daniels	1	11.0	1.00	1.40**	1.70
Dawson	1	7.0	.90	1.20	1.60
	2	8.0	.90	1.20**	1.60
	3	9.0	.90	1.20	1.60
Fallon	1	8.0	.90	1.20	1.50
	2	10.0	.90	1.20**	1.50
McCone	1	8.0	1.00	1.30	1.70
	2	9.0	1.00	1.30**	1.70
Richland	1	10.5	1.00	1.30	1.60
	2	9.5	1.00	1.30**	1.60
Roosevelt	1	10.5	.90	1.20	1.40
Sheridan	1	9.0	.80	1.10	1.40
	2	12.0	1.00	1.40**	1.70
	3	13.0	1.10	1.50	1.90
Valley	1	7.0	.70	.90	1.10
	2	10.0	.90	1.10**	1.40
	3	11.0	1.00	1.30	1.60
		North Central			
Cascade	1	12.0	.80	1.00	1.30
	2	15.0	.80	1.00**	1.30
Chouteau	1	10.5	.70	1.00	1.20
	2	12.5	.70	1.00	1.20
	3	13.5	.70	1.00**	1.20
	4	15.5	.70	1.00	1.20
Fergus	1	8.5	.70	.90	1.20
	2	11.5	.70	.90**	1.20
	3	14.5	.70	.90	1.20

See footnotes on following page.

TABLE IIIB. (Cont.) MONTANA FEDERAL BARLEY-CROP INSURANCE, BUSHEL GUARANTEE, AND PREMIUM RATES PER ACRE FOR VARIOUS PRICE LEVEL CHOICES, 1964, COUNTIES IN MONTANA CASH-GRAIN AREAS. *

County	Area No.	Guarantee Per Acre	PRICES PER BUSHEL[a/]		
			$0.60	$0.80	$1.00
			PREMIUM RATE PER ACRE		
		Bu.	Dol.	Dol.	Dol.
Glacier	1	12.0	.90	1.20**	1.50
	2	15.0	1.20	1.50	1.90
Hill	1	8.0	1.20	1.50	1.90
	2	12.0	1.20	1.50**	1.90
Judith Basin	1	11.5	.60	.80**	1.00
	2	13.5	.70	1.00	1.20
Liberty	1	12.0	1.30	1.70	2.10
	2	13.5	1.30	1.70**	2.10
Pondera	1	16.5	.90	1.20**	1.60
Teton	1	13.5	.80	1.10	1.40
	2	15.5	.80	1.10**	1.40
Toole	1	12.0	.90	1.20**	1.50
	2	15.0	1.20	1.50	1.90
			South Central		
Big Horn	1	8.0	.80	1.10	1.30
	2	11.0	.80	1.10**	1.30
	3	13.0	.80	1.10	1.30
Stillwater	1	9.0	.70	.90	1.20
	2	12.0	.70	.90**	1.20
	3	14.0	.70	.90	1.20
Yellowstone	1	14.0	.80	1.10**	1.40

* Source: Montana--Barley Crop Insurance--1964 and Succeeding Crop Years, (FCIC Rate Schedule).

a/ The premium rate chosen for Table IV is indicated (**).

TABLE IV. COST OF FEDERAL CROP INSURANCE FOR CASH GRAIN FARMS OF 830, 1200, AND 1700 ACRES, MONTANA CASH-GRAIN AREAS.*

Farm Size	Crop	Acres In Crop	X	Rate Per Acre a/	=	Premium
Acres		Acres		Dol.		Dol.
		NORTHEASTERN				
830	Wheat	280		1.88		526
	Barley	120		1.26		151
1200	Wheat	405		1.80		729
	Barley	173		1.26		218
1700	Wheat	574		1.76		1010
	Barley	246		1.26		310
		NORTH CENTRAL				
830	Wheat	280		1.59		445
	Barley	120		1.16		139
1200	Wheat	405		1.53		620
	Barley	173		1.16		201
1700	Wheat	574		1.49		855
	Barley	246		1.16		286
		SOUTH CENTRAL				
830	Wheat	280		1.66		465
	Barley	120		1.03		124
1200	Wheat	405		1.59		644
	Barley	173		1.03		178
1700	Wheat	574		1.56		895
	Barley	246		1.03		254

* Source: Acres in crop from Rude, LeRoy C., Land Use Alternatives for Dryland Cash Grain Operators, (Northeastern, North Central, and South Central Montana) Dept. of Ag. Ec. and Rural Soc., Mont. Ag. Exp. Sta., Bozeman, Mont., in Cooperation with U.S.D.A., A.R.S., F.E.R. Div., 1959. Rates are taken from "Montana--Wheat Crop Insurance--1964 and Succeeding Crop Years--Bushel Guarantee, Prices Per Bushel and Premium Rates," FCIC.

a/ Size discounts are applied as follows:
830-acre farm: 4%
1200-acre farm: 8%
1700-acre farm: 10%

can be made. Private insurance company rates are used, choosing what appears to be the average in each cash-grain area. The insured value was assumed to be 80 percent of the crop value, calculated by multiplying the average yields by the average price received for each crop in each area. Table V presents the details for calculating the premium used for each size farm in each cash-grain area.

Taxes: All taxes are included as a special item because they may deserve special treatment in different phases of the study.

Interest on land and buildings: This study accepts Rude's values for land and buildings as the best approximation for crop-insurance study purposes. His method was to obtain the best estimate of market values of land in the particular areas. This represents the opportunity cost of farmer's investment in his real estate. Likewise, no significant reason is found to deviate from his interest rate of 4.5 percent.

However, Tables VIIA, B, and C show that the real estate item is a sizable portion of the total expenses, and consequently the use of other interest rates and land values will appreciably affect the figures for total investment in the crop. Here again, adjustments can be made where necessary to fit individual situations.

Family-living allowance: A definition of family-living allowance is guided by two considerations: First, providing for family living is necessary to the solvency of the farm enterprise. Providing for a minimum or subsistence amount of family-living expense takes precedence over meeting all other expenses. Second, family-living allowance includes the value of labor contributed by the family to the farm operation.

The definition of family-living allowance is an amount that best approximates these two considerations. Three methods were

TABLE V. COST OF HAIL INSURANCE FOR CASH GRAIN FARMS OF 830, 1200, AND 1700 ACRES, MONTANA CASH-GRAIN AREAS, 80 PERCENT COVERAGE.*

Farm Size	Crop	Acres in Crop	X Av. Yield	X Percent Coverage	X Price Per Bu.	X Ins. Rate	= Premium
Acres		Acres	Bu.	%	Dol.	%	Dol.
			NORTHEASTERN				
830	Sp. wheat	280	13.0	80	1.73	8	403
	Barley	120	17.4	80	.79	8	106
1200	Sp. wheat	405	13.0	80	1.73	8	533
	Barley	173	17.4	80	.79	8	152
1700	Sp. wheat	574	13.0	80	1.73	8	826
	Barley	246	17.4	80	.79	8	217
			NORTH CENTRAL				
830	Wtr. wheat	252	20.2	80	1.61	7	459
	Sp. wheat	28	15.7	80	1.62	7	40
	Barley	120	25.0	80	.59	7	99
1200	Wtr. wheat	365	20.2	80	1.61	7	665
	Sp. wheat	40	15.7	80	1.62	7	57
	Barley	173	25.0	80	.59	7	143
1700	Wtr. wheat	517	20.2	80	1.61	7	943
	Sp. wheat	57	15.7	80	1.62	7	81
	Barley	246	25.0	80	.59	7	203
			SOUTH CENTRAL				
830	Wtr. wheat	280	17.3	80	1.61	10	624
	Barley	120	19.2	80	.58	10	107
1200	Wtr. wheat	405	17.3	80	1.61	10	902
	Barley	173	19.2	80	.58	10	154
1700	Wtr. wheat	574	17.3	80	1.61	10	1,279
	Barley	246	19.2	80	.58	10	219

*Source: Acres in crop, average yield, and price per bushel are from Rude, L. C., Land Use Alternatives for Dryland Cash Grain Operators (Northeastern, North Central, and South Central Montana) Dept. of Ag. Ec. and Rural Soc., Mont. Ag. Exp. Sta., Bozeman, Mont., in Cooperation with U.S.D.A., A.R.S., F.E.R. Div., 1959.
Insurance rates are selected as the best approximations to the average rate, from a map on which are plotted the rates listed in Rates and Rules for Crop-Hail Insurance, Montana, Crop-Hail Insurance Actuarial Association, Chicago, 1962-CHIAA No. 135.

used as guides to determining an appropriate allowance, of which the following appeared to be the most useful:

(1) Average net residual returns after deducting all costs from gross farm income are sometimes considered returns for family living. Rude's reports are again used to illustrate results that can be obtained this way. Since his reports include hired labor in the residual results, the allowances for hired-labor hours (from Table II above) are deducted, with the results shown in Table VI.

The significant variation from $740 on the 830-acre Northeastern farm to $4,687 on the 1700-acre North Central farm indicates that the residuals are functions of factors other than the value of family-labor contribution and family-living needs. A constant land value and interest rate were used on all three sizes of farms in each area. Thus, the residual reflects differences due to scale, between the various size farms. The residual returns are highest for the higher-yielding North Central area, and lowest for the lower-yielding Northeastern area. An average of all the "net returns to family living" of Table VI is about $2,200, which will be used to substantiate our final choice of family-living allowance in the conclusions to follow.

(2) The opportunity-cost approach is another guide for choosing a figure for family-living allowance. This involves assumptions regarding the type of employment for which the farm operator may be qualified. For example, because of the high degree of farm mechanization, Montana farm operators should be qualified as equipment-operator and mechanic positions with a minimum of special training. The average weekly earnings in the contract highway and street construction industry in the

TABLE VI. SUMMARY OF RESIDUAL RETURNS TO LABOR AND MANAGEMENT AND ALLOWANCES FOR HIRED LABOR ON CASH GRAIN FARMS OF 830, 1200 AND 1700 ACRES, WHEAT AND BARLEY ENTERPRISE, MONTANA CASH-GRAIN AREAS. *

Farm Size	Montana Cash Grain Areas		
	Northeastern	North Central	South Central
	Dol.	Dol.	Dol.
830-acre farm			
Residual return (No hired labor assumed)	740	1,741	1,177
1200-acre farm			
Residual return	1,431	3,249	2,048
Less hired-labor allowance	219	189	315
Net return to family-living	1,212	3,060	1,733
1700-acre farm			
Residual return	2,792	5,260	3,693
Less hired-labor allowance	634	573	488
Net return to family-living	2,158	4,687	3,205

* Source: Rude, L. C., Land Use Alternatives for Dryland Cash Grain Operators, (Northeastern, North Central, and South Central Montana) Dept. of Ag. Econ. and Rural Soc., Montana Agr. Exp. Sta., Bozeman, Montana, in cooperation with U.S.D.A., A.R.S., F.E.R. Div., 1959, Table 2, 3, and 4 of each report. Hired-labor allowance is from Table II of this report.

United States for 1962 was $118.37 per week, or approximately $6,000 per year. 8/ This figure must be adjusted to a farm basis: A rental allowance of $100 per month should be deducted, plus a travel adjustment of $50 per month, and also

8/ U.S. Dept. of Labor, Monthly Labor Review, Vol. 86, No. 12, Dec., 1963, page 1482, Table C. If Montana industry is used as a base, the estimate should possibly be discounted for seasonality. However, the data already has some seasonality built into it, and other factors, such as higher hourly earnings tend to balance the seasonality factor.

$100 per month for farm-produced food. The total of these adjustments is $250 per month, leaving a net annual opportunity allowance for management labor of $3,000.

Another guide for estimating the opportunity cost is an average of non-farm annual income for the Western region. Ruttan used such a figure in his analysis of farm, rural non-farm, and urban incomes. 9/ The median urban income for 1960 was $6,564 per family. After making the allowances for rent, travel, and farm food contribution, the net opportunity allowance would not differ appreciably from the $3,000 estimated by the method above.

Brewster, in a study of resources needed for specified income levels in 1954, chose an annual income of $3,500 for wheat farms in the Triangle-Judith Basin of Montana. 10/ He chose this level because it "approximated the 1954 median earnings of semi-skilled workers in nonfarm employment in each of the states considered." 11/

The consumer price index has risen about 12 percent (from 93 to 105) from 1954 to 1963, so the $3,500 in 1954 would be equivalent to nearly $4,000 in 1963. 12/ Apparently no adjustments were made for rent, travel, and farm-produced food, so this figure would be considerably lower than the $6,500 median urban income of Ruttan's study, or the figure of $6,000 derived from the weekly earnings in contract highway and street construction.

9/ Ruttan, Vernon W., "The Human Resource Problem in American Agriculture," Farming, Farmers, and Markets for Farm Goods, Sup. paper No. 15, Committee for Economic Development, Nov. 1962, Table 4 page 80.

10/ Brewster, John M. Farm Resources Needed for Specified Income Levels, Agric. Res. Serv., U.S.D.A., Ag. Info. Bulletin No. 180, Dec., 1957.

11/ Ibid., page 5.

12/ Federal Reserve Bulletin, Oct. 1963, "Selected Business Indexes" page 1450.

(3) The minimum essentials approach is a third guide that can be used in selecting a figure for family-living allowance. Protection of the solvency of a farm enterprise is a basic purpose of crop insurance. Family-living necessities are non-deferrable expenses during crop preparations. These could be considered a minimum estimate of returns to the operator's labor that must be covered as part of the complete investment in the crop. A study of cash family-living expenses on farms is complicated by assumptions regarding the use of farm-produced food, levels of recreation, education, and material possessions. A study of account-keeping families in Minnesota showed an expenditure of about $2,000 in 1961 for clothing, medical care, furniture and equipment, and food. 13/ Since Montana cash grain farms commonly have little or no livestock and usually little farm-produced food, cash expenditures would be higher than those for the Minnesota farms where mixed enterprises prevail. Whereas the $2,000 in the Minnesota study does not include recreation and education, an estimate of $3,000 to $4,000 is more in line for expenses that must be met each year for family living on Montana farms.

A conclusion from the above discussion is that the following family-living allowances are reasonable and allow arbitrary differences between sizes of farms: $3,000, $3,500, and $4,000 for the 830, 1,200 and 1,700-acre farms respectively. The tables in this study are set up to facilitate substitutions appropriate to individual situations in the field, or pertinent to other studies.

13/ U.S.D.A., Agricultural Statistics, 1962, Table 808, page 683.

Levels of Investment

The following questions are raised when the undefined term "investment in the crop" is used:

1. Does it include interest and depreciation on machinery and equipment?
2. Does it include harvest expense, crop insurance and taxes?
3. Does it include family-living allowance?
4. Does it include interest on the investment in real estate?

The expenses listed in Tables VIIA, B and C are progressively totalled at various levels corresponding to various concepts that individuals have in mind when using the term "investment in the crop":

Variable preharvest expenses: This includes expenses of operations and excludes capital expenses. It is comparable to what is meant by some when they refer to "out-of-pocket" expenses.

Total preharvest expenses: This item contains the above variable preharvest expenses plus the interest and depreciation on machinery and equipment (machinery-ownership expense).

Total expenses less family-living and land: For this item crop insurance, taxes and variable harvest expenses are added to total preharvest expenses.

Total expenses except land: The allowance for family living is added to the above expenses.

Total expenses: This is the total of all expenses which must be met to maintain solvency of the enterprise, including a return of 4.5 percent on the investment in land, and a family-living allowance related to opportunity cost.

All expense items are summarized on a per-acre-in-crop basis in Table VIII for convenience in making comparisons with the available levels of crop insurance, or with yield records in the various wheat areas. One observation is that the expenses are evenly divided between the five main levels of "crop investment." The variable preharvest expenses are relatively

TABLE VIIA. EXPENSES FOR MONTANA CASH GRAIN AREA FARMS OF 830 ACRES.*

Expense Items	Northeastern Total	Northeastern Per-Acre in Crops[a]	North Central Total	North Central Per-Acre in Crops[a]	South Central Total	South Central Per-Acre in Crops[a]
	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
Preharvest						
Fuel, oil and repairs	610	1.53	511	1.28	780	1.95
Seed and treatment	637	1.59	576	1.44	571	1.43
Weed spraying	500	1.25	500	1.25	500	1.25
Motor vehicles[b]	445	1.11	357	.89	307	.77
Insurance	127	.32	152	.38	150	.38
Miscellaneous costs	50	.12	50	.12	50	.12
Total variable preharvest	2,369	5.92	2,146	5.36	2,358	5.90
Machinery ownership	1,861	4.65	2,631	6.58	2,271	5.68
(Combine)	(525)	(1.31)	(663)	(1.66)	(609)	(1.52)
Total preharvest	4,230	10.57	4,777	11.94	4,629	11.58
Variable harvest						
Fuel, oil and repairs	215	.54	196	.49	213	.53
Motor vehicles[b]	130	.33	100	.25	119	.30
Grain storage	201	.50	298	.75	252	.63
Miscellaneous costs	25	.06	25	.06	25	.06
Total variable harvest	571	1.43	619	1.55	609	1.52
All-risk crop insurance	677	1.69	584	1.46	589	1.47
Hail insurance	509	1.27	598	1.50	731	1.83
Taxes	315	.79	409	1.02	304	.76
Total expenses except family-living and land	6,302	15.75	6,987	17.47	6,862	17.16
Family-living allowance	3,000	7.50	3,000	7.50	3,000	7.50
Total expenses except land	9,302	23.25	9,987	24.97	9,862	24.66
Interest on land	2,094	5.23	3,038	7.59	2,452	6.13
Total expenses	11,396	28.48	13,025	32.56	12,314	30.79

Source: Adapted from Rude, L.C., Land Use Alternatives for Dryland Cash Grain Operators (Northeastern, North Central, and South Central Montana) Dept. of Ag. Ec. and Rural Soc., Mont. Ag. Exp. Sta., Bozeman, Mont., in Cooperation with U.S.D.A., A.R.S., F.E.R. Div., 1959.

a/ Based on 400 acres in crop, the total insurable acreage.

b/ For the Northeastern and the North Central areas, one-half of the truck mileage is charged to harvest expense at 6¢ per mile, since a pickup truck is not included in the inventory. For the South Central area, the full truck mileage is charged to harvest at 6¢ per mile, since a pickup is included.

TABLE VIIB. EXPENSES FOR MONTANA CASH GRAIN AREA FARMS OF 1200 ACRES.*

Expense Items	Northeastern		North Central		South Central	
	Total	Per-Acre in Crop a/	Total	Per-Acre in Crop a/	Total	Per-Acre in Crop a/
	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
Preharvest						
Hired labor	169	.28	137	.24	289	.50
Fuel, oil and repairs	703	1.22	644	1.11	868	1.51
Seed and treatment	922	1.60	833	1.45	827	1.44
Weed spraying	723	1.25	723	1.25	723	1.25
Motor vehicles b/	401	.70	342	.59	413	.71
Insurance	155	.27	157	.27	179	.31
Miscellaneous costs	75	.13	75	.13	75	.13
Total variable preharvest	3,148	5.45	2,911	5.04	3,374	5.85
Machinery ownership	2,572	4.45	3,214	5.56	3,159	5.46
(Combine)	(627)	(1.08)	(663)	(1.15)	(567)	(.98)
Total preharvest	5,720	9.90	6,125	10.60	6,533	11.31
Variable harvest						
Hired labor	50	.09	52	.09	26	.04
Fuel, oil and repairs	278	.48	251	.43	252	.44
Motor vehicles b/	258	.45	196	.34	187	.32
Custom combining	193	.33	221	.38	175	.30
Grain storage	290	.50	431	.74	364	.64
Miscellaneous costs	25	.04	25	.04	25	.04
Total variable harvest	1,094	1.89	1,176	2.02	1,029	1.78
All-risk crop insurance	947	1.64	821	1.42	822	1.42
Hail insurance	735	1.27	865	1.50	1,056	1.83
Taxes	447	.77	577	1.00	433	.75
Total expenses except family-living and land	8,943	15.47	9,564	16.54	9,873	17.09
Family-living allowance	3,500	6.06	3,500	6.06	3,500	6.06
Total expenses except land	12,443	21.53	13,064	22.60	13,373	23.15
Interest on land	3,014	5.21	4,393	7.60	3,533	6.11
Total expenses	15,457	26.74	17,457	30.20	16,906	29.26

* Source: Adapted from Rude, see Table VIIA.

a/ Based on 578 acres in crop, the total insurable acreage.

b/ The total variable truck expense is charged to harvest expenses at 6¢ per mile.

TABLE VIIC. EXPENSES FOR MONTANA CASH GRAIN AREA FARMS OF 1700 ACRES.*

Expense Items	Northeastern		North Central		South Central	
	Total	Per-Acre in Crop a/	Total	Per-Acre in Crop a/	Total	Per-Acre in Crop a/
	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
Preharvest						
Hired labor	422	.52	381	.47	462	.56
Fuel, oil and repairs	1,099	1.34	1,088	1.32	1,071	1.31
Seed and treatment	1,306	1.59	1,179	1.44	1,186	1.45
Weed spraying	1,025	1.25	1,025	1.25	1,025	1.25
Motor vehicles b/	486	.59	415	.51	389	.47
Insurance	204	.25	206	.25	205	.25
Miscellaneous costs	90	.11	90	.11	90	.11
Total variable preharvest	4,632	5.65	4,384	5.35	4,428	5.40
Machinery ownership	3,220	3.93	4,228	5.16	3,437	4.19
(Combine)	(886)	(1.08)	(1,275)	(1.56	(627)	(.77)
Total preharvest	7,852	9.58	8,612	10.51	7,865	9.59
Variable harvest						
Hired labor	212	.26	192	.23	26	.03
Fuel, oil and repairs	478	.59	398	.49	251	.31
Motor vehicles b/	303	.37	229	.28	363	.44
Custom combining c/	---	----	---	----	970	1.19
Grain storage	411	.50	611	.75	518	.63
Miscellaneous costs	35	.04	35	.04	35	.04
Total variable harvest	1,439	1.76	1,465	1.79	2,163	2.64
All-risk crop insurance	1,320	1.61	1,141	1.39	1,149	1.40
Hail insurance	1,043	1.27	1,227	1.50	1,498	1.83
Taxes	610	.74	784	.96	561	.68
Total expenses except family-living and land	12,264	14.96	13,229	16.15	13,236	16.14
Family-living allowance	4,000	4.88	4,000	4.88	4,000	4.88
Total expenses except land	16,264	19.84	17,229	21.03	17,236	21.02
Interest on Land	4,231	5.16	6,182	7.53	5,035	6.14
Total expenses	20,495	25.00	23,411	28.56	22,271	27.16

* Source: Adapted from Rude, see Table VIIA.

a/ Based on 820 acres, the total insurable acreage.

b/ The cost of operation of the 2-ton truck is charged to harvest for its total mileage at 6¢ per mile, or where there are two pickups plus one truck, the larger pickup and truck are charged to harvest at 6¢ per mile.

c/ The Northeastern budget includes two combines, a self-propelled and a pull-type; the North Central, two self-propelled; and the South Central, one self-propelled.

TABLE VIII. SUMMARY OF EXPENSES PER CROP ACRE FOR CASH GRAIN FARMS OF 830, 1200, AND 1700 ACRES, MONTANA CASH GRAIN AREAS.

Expense Items	Northeastern			North Central			South Central		
	830-Acre	1200-Acre	1700-Acre	830-Acre	1200-Acre	1700-Acre	830-Acre	1200-Acre	1700-Acre
	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
Variable preharvest	5.92	5.45	5.65	5.36	5.04	5.35	5.90	5.85	5.40
Machinery ownership	4.65	4.45	3.93	6.58	5.56	5.16	5.68	5.46	4.19
(Combine)	(1.31)	(1.08)	(1.08)	(1.66)	(1.15)	(1.56)	(1.52)	(.98)	(.77)
Total preharvest	10.57	9.90	9.58	11.94	10.60	10.51	11.58	11.31	9.59
Variable harvest	1.43	1.89	1.76	1.55	2.02	1.79	1.52	1.78	2.64
All-risk crop insurance	1.69	1.64	1.61	1.46	1.42	1.39	1.47	1.42	1.40
Hail insurance	1.27	1.27	1.27	1.50	1.50	1.50	1.83	1.83	1.83
Taxes	.79	.77	.74	1.02	1.00	.96	.76	.75	.68
Total expenses except family-living & land	15.75	15.47	14.96	17.47	16.54	16.15	17.16	17.09	16.14
Family-living allowance	7.50	6.06	4.88	7.50	6.06	4.88	7.50	6.06	4.88
Total expenses except land	23.25	21.53	19.84	24.97	22.60	21.03	24.66	23.15	21.02
Interest on land	5.23	5.21	5.16	7.59	7.60	7.53	6.13	6.11	6.14
Total expenses	28.48	26.74	25.00	32.56	30.20	28.56	30.79	29.26	27.16

constant per acre for all sizes of farms in all areas, although machinery ownership is appreciatly lower for the Northeastern area. There is little per-acre variation in harvest expense, crop insurance and taxes. Since the family-living allowance is constant in all areas for each of the three farm sizes, the per-acre allowance decreases proportionately with the increase in size of farm. The interest on land investment is about 50 percent higher in the North Central area than in the Northeastern, with the South Central in between. This cost accounts for a fifth to a quarter of total farm expenses.

Deferrable Expenses

Farmers who have few or no fixed debt payments and relatively stable enterprises, are often more interested in protecting the non-deferrable expenses of operation. They would be willing to forego interest on their investment in equipment and land, postpone depreciation reserves, and may even be willing to draw some living expenses out of savings. The important consideration here is how many years an operator can defer expenses, and what risk he wants to take on the catastrophe loss that may eliminate any opportunity to ever make up this part of expenses.

Depreciation reserves should be considered differently than interest on investment because if depreciation reserves are not regularly maintained, capital depletion is incurred and high-cost borrowing may become necessary. Whereas, foregoing interest (unless a fixed payment to a credit institution) only involves decreased income to the capital owner.

Taxes are deferrable, but only with penalty and interest. Here again the important consideration is the risk the operator wants to take in accumulating the deferrable expenses over periods of more than one year.

Crop insurance cannot be considered deferrable. The choice is whether or not to buy it, not whether payment can be deferred.

For continued success of the enterprise, none of the expenses can be deferred indefinitely. For just maintaining solvency, the only expense that can be deferred indefinitely is the interest on the investment, and this only if there are no fixed debt payments--if land and equipment are paid for.

Financial Restoration

Crop Investment Recovered from Profits

An impressive FCIC sales approach used in selling crop insurance is to point out to the prospective insured that crop investment represents past profit or borrowed money (which must be paid back out of profits). The procedure used in "A Plan" (FCIC sales folder) is to estimate the average percentage profit margin and from that percentage determine how many dollar's worth of crop must be sold to obtain a dollar profit. The crop-investment loss is multiplied by this crop-sale factor to determine the amount of crop that must be sold to recover the investment loss. Figure 2 is a hypothetical example of the concept. The reasoning implies that the investment in the crop in year 5 originates from profits accumulated from a constant percentage of the crops of years 1 through 4. If the crop in year 5 is a failure, then it will take the profits from the years 6 through 9 to recover the investment profits of years 1 through 4.

This sales approach overlooks the fact that the average yield is a function of good and bad years. Also, it assumes variable rather than constant costs. The actual situation is more like Figure 3. The average of incomes in years 1 through 4 are assumed to cover total investment and profit. Previously in this study we have shown that costs are relatively constant. If a crop failure or near failure occurs in year 5, the loss of 4 years average profits (assuming year 5 through an indefinite number of years will average the same as years 1 through 4) will eventually be made up from the net crop production above the average level.

This analysis illustrates the point that the farmer's concern is not how many average crops it will take to make up the loss of the crop investment, but how soon the loss can be made up, and what the chance is of several consecutive years of investment loss.

However, the profit idea may still be worthy of attention in helping the farmer to understand his loss situation. The FCIC Sales Manual contains an excerpt from an information release to the effect that farmers market $5 in produce to earn $1 in income for families:

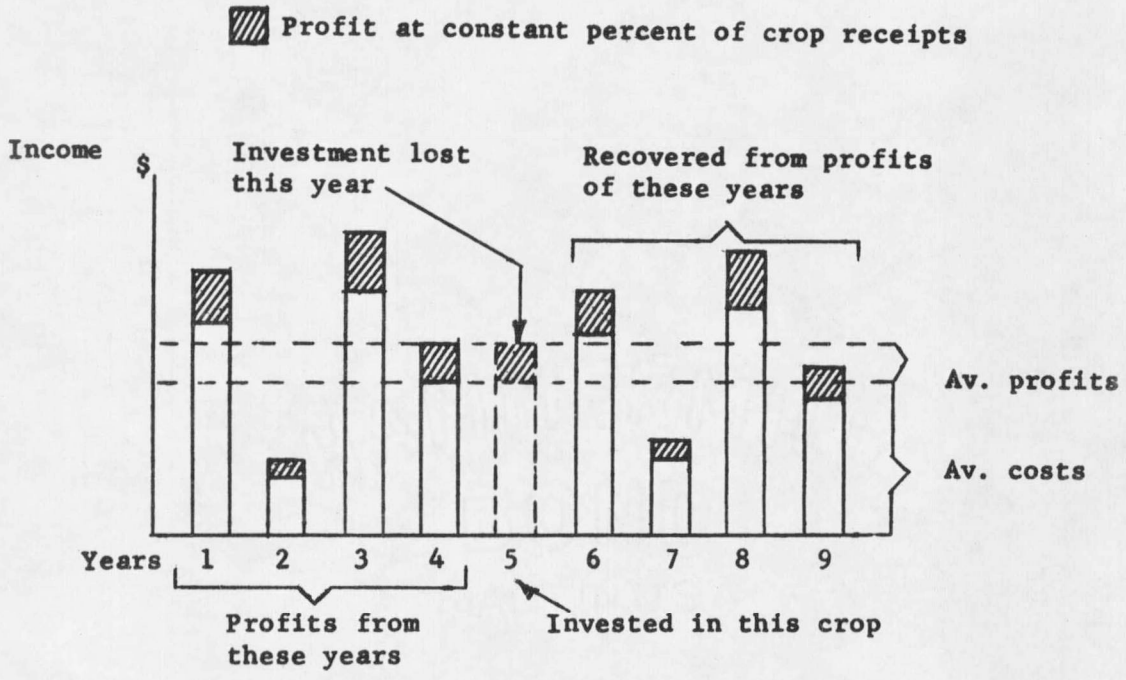

Figure 2. Representation of Investment Loss Replaced by Profits Per FCIC "A Plan".

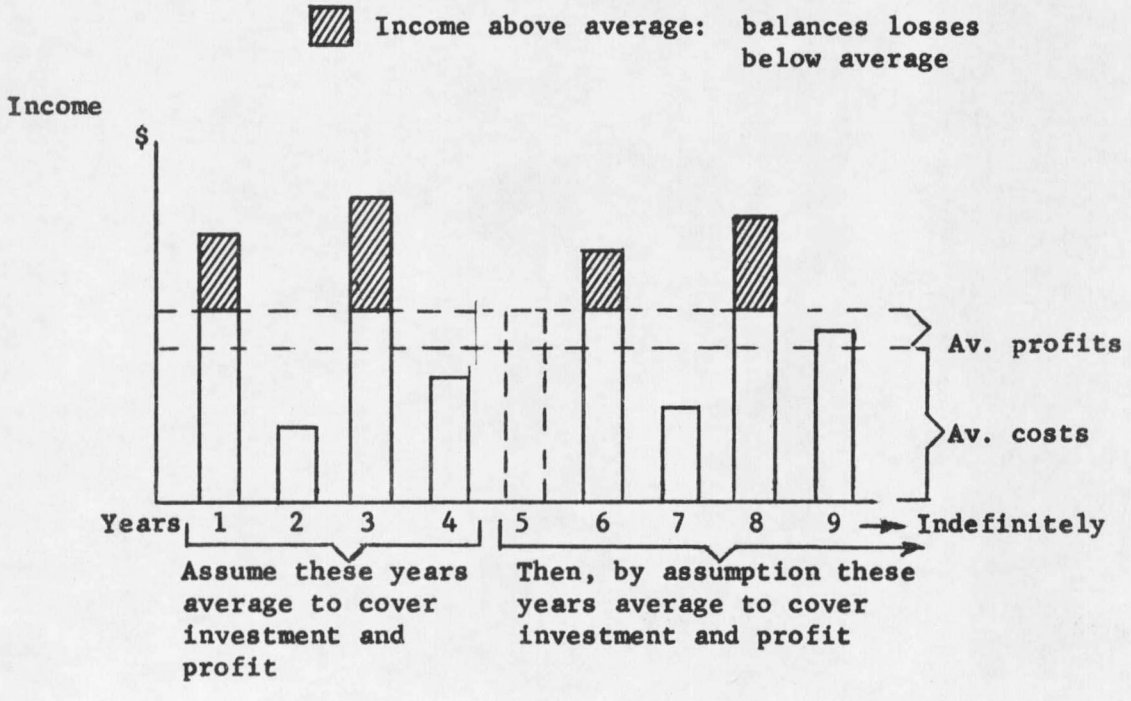

Figure 3. Representation of Investment Loss Recovered From Excess Profits of Above-Average Years.

> In order to have $1 of earnings left for his family, a farmer must sell approximately $5 worth of products from his farm. This was the conclusion of a recent study on resource requirements.
>
> Following the rule of thumb of $1 out of $5, gross sales of $13,400 to $26,800 would be necessary to give a farm operator an income of $2,500 to $5,500 yearly. Incomes in this range are roughly equal to wages for skilled and semiskilled nonfarm workers. 14/

Considerable profit variation exists between sizes of farms and locations, and profits depend upon assumptions concerning interest, depreciation, and whether or not costs include crop insurance. Rude's reports show a residual return to labor and management. In Table IX allowances for hired labor (from Table VI) are deducted, and a "profit margin" is calculated by dividing the residual return to management by the gross income from sales. These "profit margins" vary from 8.8 percent for the 1,200-acre farm in the Northeastern cash-grain area, to 22.7 percent for the 1,700-acre farm in the North Central area.

One of the best uses that can be made of a profit margin analysis is to demonstrate a producer's vulnerability to crop failures. If a farmer is operating a unit comparable to the Northeastern 830-acre farm, he is much more vulnerable to loss of crop investment than the farmer on a unit similar to the 1,700-acre North Central farm. An operator who has fixed payments on obligations can more accurately determine how vulnerable he is to crop loss by comparing his individual financial situation and production expectations with these crop-investment and profit data based on averages.

Yields Required to Cover Several Levels of Investment

A farmer's decision-making will benefit from an understanding of yields required to recover from a loss of crop investment. If he is concerned with when he can recover from a loss, he needs to have some idea of yields necessary to meet investment levels. From experience he has developed some ordered expectations of yields.

14/ FCIC Sales Manual: "Farm Experts Report" Reproduced from Economics Research Service, U.S.D.A.

Again, using Rude's budgets for three sizes of farms in the three cash-grain areas of Montana, yields required to meet the five levels of crop investment have been calculated, Table X. Rude's prices and average yields were used as a base, and applied to the same proportion of land in

TABLE IX. SUMMARY OF RESIDUAL RETURNS TO LABOR AND MANAGEMENT AND PROFIT MARGINS FOR CASH GRAIN FARMS OF 830, 1200, AND 1700 ACRES, WHEAT AND BARLEY ENTERPRISE, MONTANA CASH GRAIN AREAS. *

Cash Grain Areas and Farm Size	Return to Labor & Mgt.	Hired Labor Allow	Return to Manage-ment.	Gross Income From Sales	Profit Margin
	Dol.	Dol.	Dol.	Dol.	Percent
Northeastern					
830-acre	740	---	740	7,347	10.1
1200-acre	1,431	219	1,212	10,615	8.8
1700-acre	2,792	634	2,158	15,055	14.3
North Central					
830-acre	1,741	---	1,741	10,045	17.3
1200-acre	3,249	189	3,060	14,551	21.0
1700-acre	5,260	573	4,687	20,626	22.7
South Central					
830-acre	1,177	---	1,177	8,633	13.6
1200-acre	2,048	315	1,733	12,484	13.9
1700-acre	3,693	488	3,205	17,714	18.1

* Source: Rude, L. C., Land Use Alternatives for Dryland Cash Grain Operators (Northeastern, North Central and South Central Montana) Dept. of Ag. Econ. and Rural Soc., Montana Ag. Exp. Sta., Bozeman, Montana, in cooperation with U.S.D.A., A.R.S., F.E.R. Div., 1959, Tables 2, 3 and 4 of each report. Hired-labor allowance is from Table I of this report.

TABLE X. YIELDS OF WHEAT AND BARLEY REQUIRED TO PRODUCE INCOME EQUAL TO FIVE LEVELS OF INVESTMENT IN THE CROP ON MONTANA CASH-GRAIN-AREA FARMS OF 830, 1200 AND 1700 ACRES. *

Crop	Acres	Av. Yield	Total Prod'n	Price	Value	Expense at Each Level[a/]					Yield Required at Each Level				
						1	2	3	4	5	1	2	3	4	5
		Bu.	Bu.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Bu.	Bu.	Bu.	Bu.	Bu.
		Northeastern: 830-acre farm													
Wheat	280	13.0	3,640	1.73	7,947	2,369	4,230	6,302	9,302	11,396	3.9	6.9	10.3	15.2	18.6
Barley	120	17.4	2,088	.79							5.2	9.3	13.8	20.4	25.0
		Northeastern: 1200-acre farm													
Wheat	405	13.0	5,265	1.73	11,486	3,148	5,720	8,943	12,443	15,457	3.6	6.4	10.1	14.1	17.5
Barley	173	17.4	3,010	.79							4.8	8.5	13.5	18.8	23.4
		Northeastern: 1700-acre farm													
Wheat	574	13.0	7,462	1.73	16,703	4,632	7,852	12,264	16,264	20,495	3.6	6.1	9.5	12.7	16.0
Barley	276	17.4	4,802	.79							4.8	8.2	12.8	16.9	21.3
		North Central: 830-acre farm													
Wheat	280	20.2	5,656	1.61	10,876	2,146	4,777	6,987	9,987	13,025	4.0	8.9	13.0	18.5	24.2
Barley	120	25.0	3,000	.59							4.9	11.0	16.1	23.0	29.9
		North Central: 1200-acre farm													
Wheat	405	20.2	8,181	1.61	15,723	2,911	6,125	9,564	13,064	17,457	3.7	7.9	12.3	16.8	22.4
Barley	173	25.0	4,325	.59							4.6	9.7	15.2	20.8	27.8
		North Central: 1700-acre farm													
Wheat	574	20.2	11,595	1.61	22,739	4,384	8,612	13,229	17,229	23,411	3.9	7.6	11.8	15.3	20.8
Barley	276	25.0	6,900	.59							4.8	9.5	14.5	18.9	25.7
		South Central: 830-acre farm													
Wheat	280	17.3	4,844	1.61	9,135	2,358	4,629	6,862	9,862	12,314	4.5	8.8	13.0	18.7	23.3
Barley	120	19.2	2,304	.58							5.0	9.7	14.4	20.7	25.9
		South Central: 1200-acre farm													
Wheat	405	17.3	7,007	1.61	13,208	3,374	6,533	9,873	13,373	16,906	4.4	8.6	12.9	17.5	22.1
Barley	173	19.2	3,322	.58							4.9	9.5	14.4	19.4	24.6
		South Central: 1700-acre farm													
Wheat	574	17.3	9,930	1.61	19,061	4,428	7,865	13,236	17,236	22,271	4.0	7.1	12.0	15.6	20.2
Barley	276	19.2	5,299	.58							4.5	7.9	13.3	17.4	22.4

* Source: Rude, L. C., Land Use Alternatives for Dryland Cash Grain Operators (Northeastern Montana, North Central Montana, and South Central Montana) Dept. of Ag. Econ. and Rural Soc., Mont. Ag. Exp. Sta., Bozeman, Montana, in cooperation with U.S.D.A., A.R.S., F.E.R. Div., 1959, and Tables VIIA, B, and C.

a/ Expense levels correspond with those of Tables VIIA, B, and C: (1) Total variable preharvest, (2) Total preharvest, (3) Total expenses except family-living and land, (4) Total expenses except land, (5) Total expenses.

wheat and barley for each yield level required, as follows:

$$\text{required yield of wheat} = \frac{\text{level of expense}}{\text{av. value of crop}} \times \text{Av. yield of wheat}$$

$$\text{required yield of barley} = \frac{\text{level of expense}}{\text{av. value of crop}} \times \text{Av. yield of barley}$$

For example, to calculate the combined yields of wheat and barley required to pay total expenses on the 830-acre farm in the Northeastern area:

$$\text{required yield of wheat} = 13.0 \times \frac{11,396}{7,947} = 18.6 \text{ bu. per acre}$$

$$\text{required yield of barley} = 17.4 \times \frac{11,396}{7,947} = 25.0 \text{ bu. per acre}$$

Individual yield and acreage situations vary considerably, and prices change over time. Therefore, the absolute yields will not always apply in individual cases. The principal value of Table X and Figures 4-6 is in showing the relationships between crop-investment levels and yields. For example, assume that a crop failure results in yields of about four bushels of wheat and five bushels of barley on the 830-acre farm in the Northeastern area, which will just cover variable preharvest expenses (see Figure 4). If this farmer wants to know how much excess yield is required to recover all his other expenses in this situation, he can see that he would need a combined excess yield of 14.5 bushels of wheat and 15.3 bushels of barley. If he figures his situation is about average, recovery would therefore require almost twice the combined average wheat and barley yields.

Carrying these figures into his decision process, the operator must estimate his probability of obtaining yields of twice the average as compared with probability of additional years of investment loss. Then to complete his decision analysis, he can fit in his individual financial status and desires: Whether or not he has fixed debt payments, of which failure to pay will threaten his solvency; whether or not he has reserves of cash or commodities that can carry him over additional crop losses; whether or not sufficient credit resources are available; the degree of

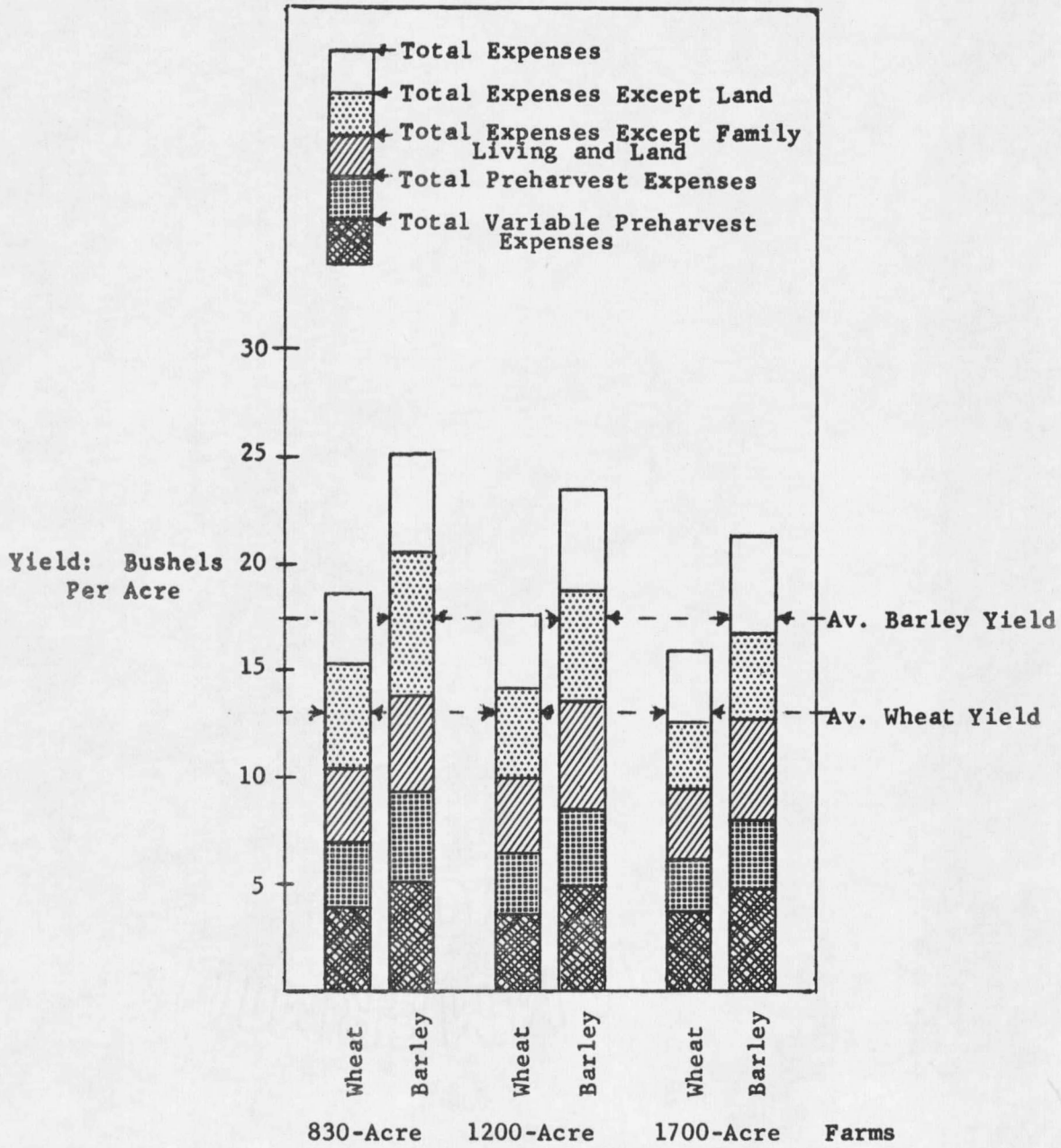

Figure 4. Combined Yields of Wheat and Barley Required for 5 Levels of Investment in Crops On 3 Sizes of Farms in NorthEastern Montana Cash Grain Area.

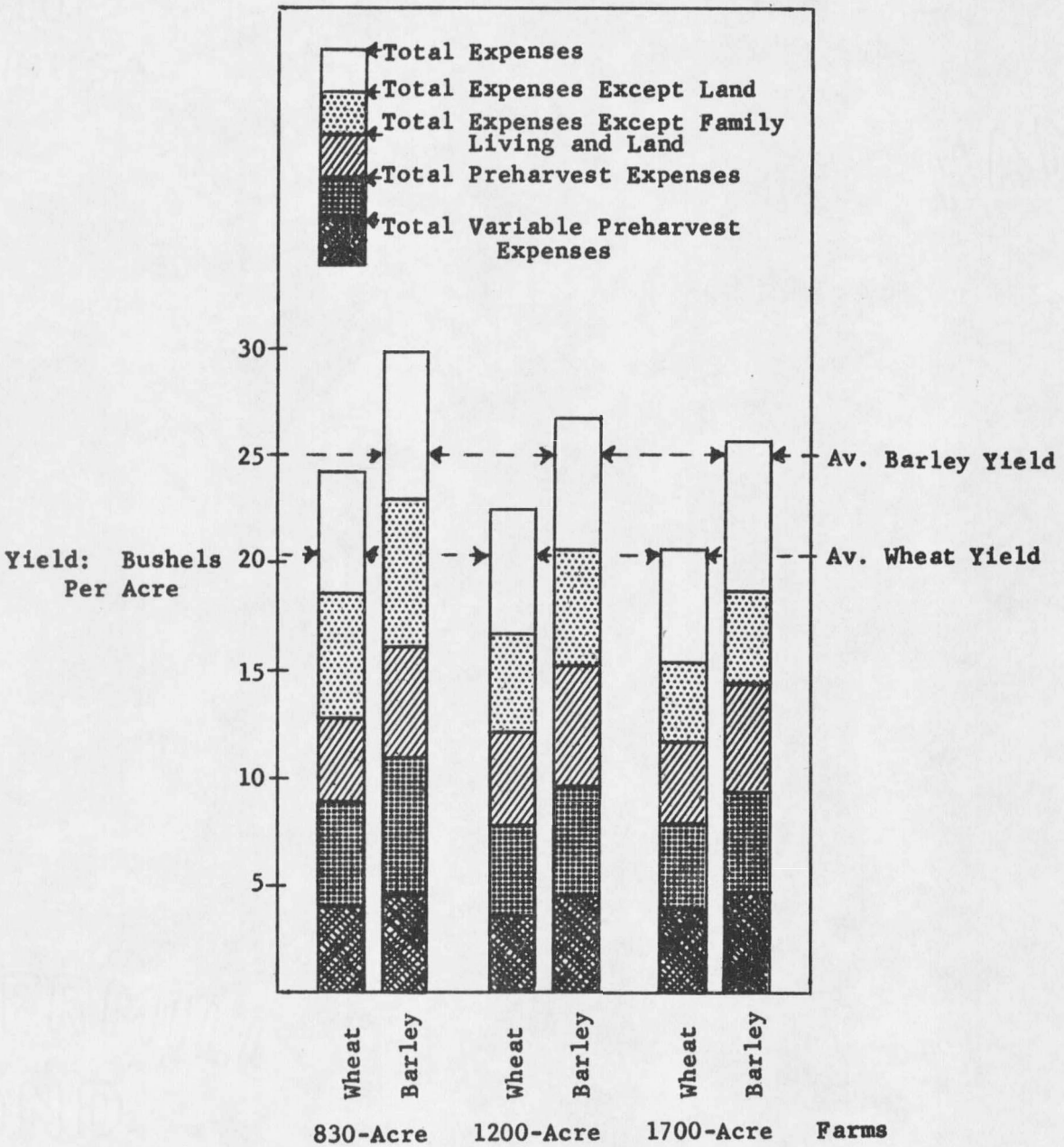

Figure 5. Combined Yields of Wheat and Barley Required for 5 Levels of Investment in Crops on 3 Sizes of Farms in North Central Montana Cash Grain Area.

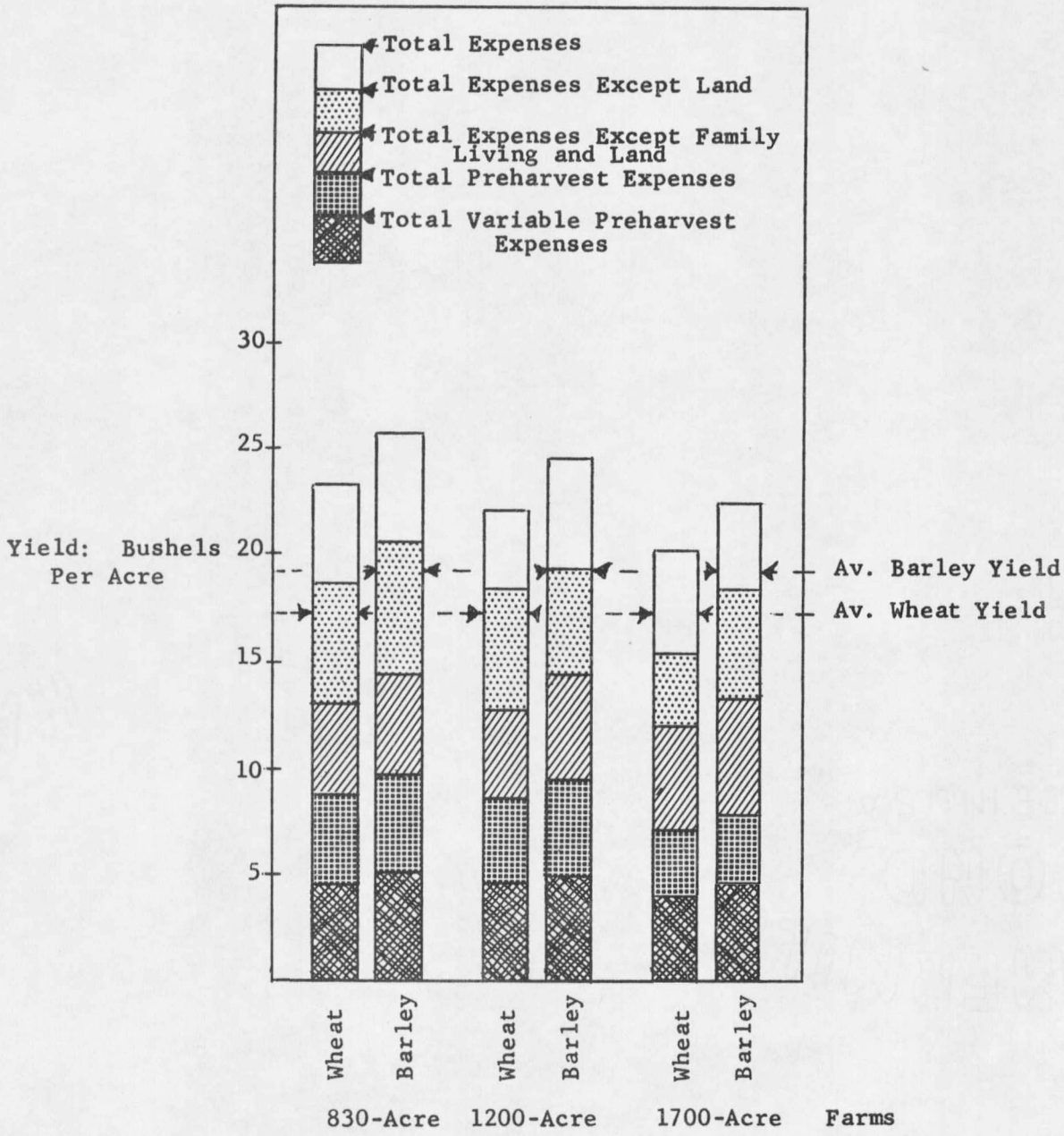

Figure 6. Combined Yields of Wheat and Barley Required for 5 Levels of Investment in Crops on 3 Sizes of Farms in South Central Montana Cash Grain Area.

risk he is willing to take in jeopardizing his solvency; and finally whether he wants to risk foregoing plans for development and expansion.

Adequacy of All-Risk Crop Insurance Coverage

The primary purpose of all-risk crop insurance is to protect the solvency of the farm business. The problem is to relate the coverage available under all-risk crop insurance to levels of investment in the crop. Rodewald indicated that insurance available in 1959 was sufficient to cover costs, including family-living allowance, in the Triangle Area of Montana (the same counties as the North Central area in this study), but was not sufficient in the Northeast Area. 15/ However, he did not attempt to show the various levels of crop investment related to levels of coverage available in the different areas. Tables XIA, B, and C show the per-acre values of wheat-crop insurance available for three price choices in each area of the cash-grain counties of Montana. Tables XIIA, B, and C show the same data for barley-crop insurance. The values for the 1,200-acre farm are graphed in Figures 7 through 12, along with the five investment levels described above demonstrating the relationship between coverage available and the level of investment in the crop in each actuarial area in each county. 16/

The 1,200-acre farm is selected for the following analysis: In the Northeastern area, Figure 7, available coverage is not sufficient to cover family living and land investment in any of the counties. Neither is it sufficient to cover all expenses except family living and land in two areas of Dawson county, nor in one area of each of all but three of the

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15/ Rodewald, Gordon, Jr., Crop Insurance in Montana, Circular No. 235, Farm Economics Div., Ec. Res. Service, USDA, in cooperation with Mont. Agr. Exp. Sta., Mont. State College, Bozeman, Mont., Nov. 1961.

16/ The comparisons are based on all-wheat or all-barley. Since cropland cannot all be planted to wheat (under the program), allowance must be made for some acreage of barley. Therefore total adequacy of coverage on a farm will be less than shown on the wheat charts, depending upon acreages of wheat and barley.

TABLE XIA. FEDERAL WHEAT-CROP INSURANCE COVERAGE AVAILABLE ON SUMMER-FALLOW, NORTHEASTERN MONTANA CASH-GRAIN AREA COUNTIES, 1964.*

County	Area No.	Guarantee Per Acre	Prices Per Bushel		
			$1.50	$1.75	$2.00
			Insurance Value Available Per Acre		
		Bu.	Dol.	Dol.	Dol.
Daniels	1	8.0	12.00	14.00	16.00
Dawson	1	6.5	9.75	11.38	13.00
	2	7.5	11.25	13.13	15.00
	3	8.5	12.75	14.88	17.00
Fallon	1	6.5	9.75	11.38	13.00
	2	8.0	12.00	14.00	16.00
McCone	1	7.0	10.50	12.25	14.00
	2	8.5	12.75	14.88	17.00
Richland	1	9.0	13.50	15.75	18.00
	2	8.0	12.00	14.00	16.00
Roosevelt	1	8.5	12.75	14.88	17.00
Sheridan	1	7.0	10.50	12.25	14.00
	2	8.0	12.00	14.00	16.00
	3	9.5	14.25	16.63	19.00
Valley	1	7.5	11.25	13.13	15.00
	2	8.0	12.00	14.00	16.00
	3	9.0	13.50	15.75	18.00
Wibaux	1	7.0	10.50	12.25	14.00
	2	8.0	12.00	14.00	16.00

* Source: Montana--Wheat Crop Insurance--1964 and Succeeding Crop Years, FCIC State Rate Sheets.

TABLE XIB. FEDERAL WHEAT-CROP INSURANCE COVERAGE AVAILABLE ON SUMMER-FALLOW, NORTH CENTRAL MONTANA CASH-GRAIN COUNTIES, 1964. *

County	Area No.	Guarantee Per Acre	Prices Per Bushel				
			$1.25	$1.50	$1.75	$2.00	$2.25
			Insurance Available Per Acre				
		Bu.	Dol.	Dol.	Dol.	Dol.	Dol.
Cascade	1	11.0	13.75		19.25		24.75
	2	13.0	16.25		22.75		29.25
Chouteau	1	9.0	11.25		15.75		20.25
	2	10.0	12.50		17.50		22.50
	3	11.0	13.75		19.25		24.75
	4	13.0	16.25		22.75		29.25
Fergus	1	8.0	10.00		14.00		18.00
	2	10.0	12.50		17.50		22.50
	3	11.5	14.38		20.13		25.88
Glacier	1	9.0	11.25		15.75		20.25
	2	11.0	13.75		19.25		24.75
Hill	1	7.0		10.50	12.25	14.00	
	2	9.0		13.50	15.75	18.00	
Judith Basin	1	8.5	10.63		14.88		19.13
	2	10.0	12.50		17.50		22.50
Liberty	1	8.5		12.75	14.88	17.00	
	2	10.0		15.00	17.50	20.00	
Pondera	1	12.0	15.00		21.00		27.00
Teton	1	9.5	11.88		16.63		21.38
	2	12.5	15.63		21.88		28.13
Toole	1	9.0	11.25		15.75		20.25
	2	11.0	13.75		19.25		24.75

* Source: Montana--Wheat Crop Insurance--1964 and Succeeding Crop Years, FCIC State Rate Sheets.

TABLE XIC. FEDERAL WHEAT-CROP INSURANCE COVERAGE AVAILABLE ON SUMMER-FALLOW, SOUTH CENTRAL MONTANA CASH GRAIN COUNTIES, 1964. *

County	Area No.	Guarantee Per Acre	Prices Per Bushel		
			$1.25	$1.75	$2.25
			Insurance Available Per Acre		
		Bu.	Dol.	Dol.	Dol.
Big Horn	1	7.0	8.75	12.25	15.75
	2	10.0	12.50	17.50	22.50
	3	12.0	15.00	21.00	27.00
Stillwater	1	8.0	10.00	14.00	18.00
	2	10.0	12.50	17.50	22.50
	3	11.0	13.75	19.25	24.75
Yellowstone	1	12.0	15.00	21.00	27.00

* Source: Montana--Wheat Crop Insurance--1964 and Succeeding Crop Years, FCIC State Rate Sheets.

TABLE XIIA. FEDERAL BARLEY-CROP INSURANCE COVERAGE AVAILABLE ON SUMMER-FALLOW, NORTHEASTERN MONTANA CASH-GRAIN COUNTIES, 1964. *

County	Area No.	Guarantee Per Acre	Prices Per Bushel		
			$0.60	$0.80	$1.00
			Insurance Available Per Acre		
		Bu.	Dol.	Dol.	Dol.
Daniels	1	11.0	6.60	8.80	11.00
Dawson	1	7.0	4.20	5.60	7.00
	2	8.0	4.80	6.40	8.00
	3	9.0	5.40	7.20	9.00
Fallon	1	8.0	4.80	6.40	8.00
	2	10.0	6.00	8.00	10.00
McCone	1	8.0	4.80	6.40	8.00
	2	9.0	5.40	7.20	9.00
Richland	1	10.5	6.30	8.40	10.50
	2	9.5	5.70	7.60	9.50
Roosevelt	1	10.5	6.30	8.40	10.50
Sheridan	1	9.0	5.40	7.20	9.00
	2	12.0	7.20	9.60	12.00
	3	13.0	7.80	10.40	13.00
Valley	1	7.0	4.20	5.60	7.00
	2	10.0	6.00	8.00	10.00
	3	11.0	6.60	8.80	11.00

* Source: Montana Barley Crop Insurance--1964 and Succeeding Years, FCIC State Rate Sheets.

TABLE XIIB. FEDERAL BARLEY-CROP INSURANCE COVERAGE AVAILABLE ON SUMMER-FALLOW, NORTH CENTRAL MONTANA CASH GRAIN COUNTIES, 1964. *

County	Area No.	Guarantee Per Acre	Prices Per Bushel		
			$0.60	$0.80	$1.00
			Insurance Available Per Acre		
		Bu.	Dol.	Dol.	Dol.
Cascade	1	12.0	7.20	9.60	12.00
	2	15.0	9.00	12.00	15.00
Chouteau	1	10.5	6.30	8.40	10.50
	2	12.5	7.50	10.00	12.50
	3	13.5	8.10	10.80	13.50
	4	15.5	9.30	12.40	15.50
Fergus	1	8.5	5.10	6.80	8.50
	2	11.5	6.90	9.20	11.50
	3	14.5	8.70	11.60	14.50
Glacier	1	12.0	7.20	9.60	12.00
	2	15.0	9.00	12.00	15.00
Hill	1	8.0	4.80	6.40	8.00
	2	12.0	7.20	9.60	12.00
Judith Basin	1	11.5	6.90	9.20	11.50
	2	13.5	8.10	10.80	13.50
Liberty	1	12.0	7.20	9.60	12.00
	2	13.5	8.10	10.80	13.50
Pondera	1	16.5	9.90	13.20	16.50
Teton	1	13.5	8.10	10.80	13.50
	2	15.5	9.30	12.40	15.50
Toole	1	12.0	7.20	9.60	12.00
	2	15.0	9.00	12.00	15.00

* Source: Montana Barley Crop Insurance--1964 and Succeeding Years, FCIC State Rate Sheets.

TABLE XIIC. FEDERAL BARLEY-CROP INSURANCE COVERAGE AVAILABLE ON SUMMER-FALLOW, SOUTH CENTRAL MONTANA CASH GRAIN COUNTIES, 1964. *

County	Area No.	Guarantee Per Acre	Prices Per Bushel		
			$0.60	$0.80	$1.00
			Insurance Available Per Acre		
		Bu.	Dol.	Dol.	Dol.
Big Horn	1	8.0	4.80	6.40	8.00
	2	11.0	6.60	8.80	11.00
	3	13.0	7.80	10.40	13.00
Stillwater	1	9.0	5.40	7.20	9.00
	2	12.0	7.20	9.60	12.00
	3	14.0	8.40	11.20	14.00
Yellowstone	1	14.0	8.40	11.20	14.00

* Source: Montana Barley Crop Insurance--1964 and Succeeding Years, FCIC State Rate Sheets.

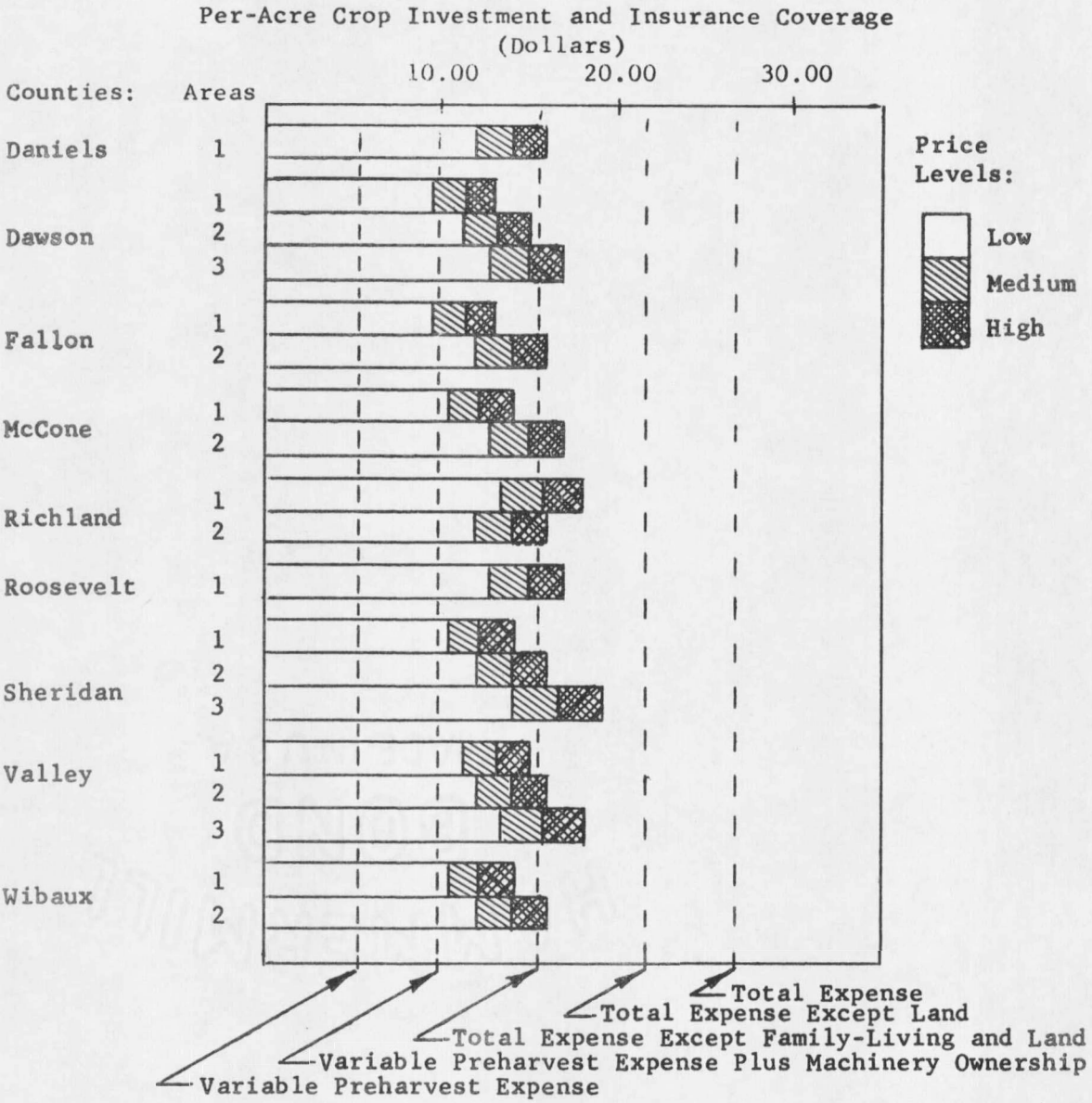

Figure 7. Federal Wheat-Crop Insurance Coverage Available At Three Price Levels, and Five Concepts of Crop-Investment-Level on 1200-Acre Farm, Northeastern Montana Cash-Grain Counties.

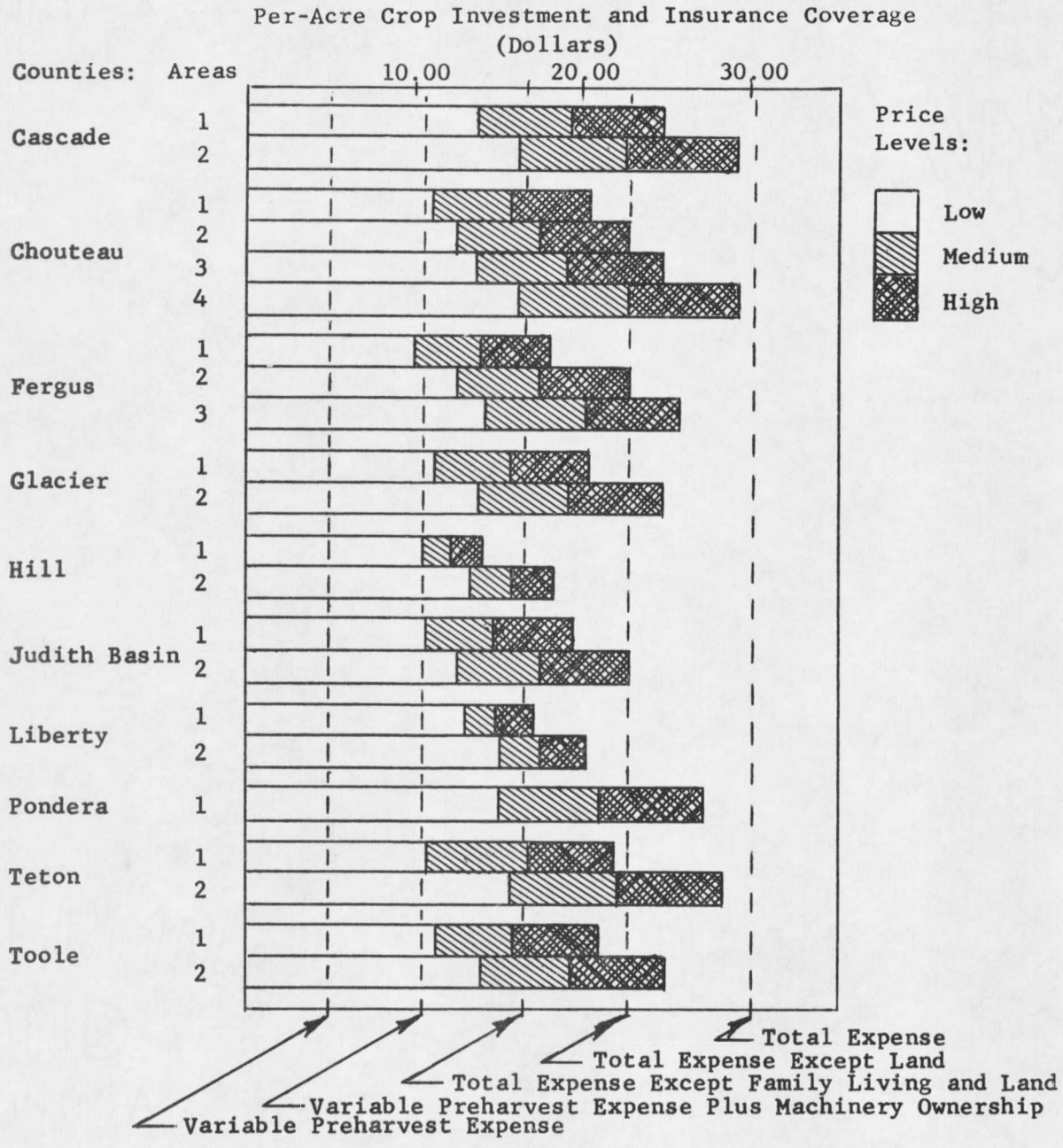

Figure 8. Federal Wheat-Crop Insurance Coverage Available at Three Price Levels, and Five Concepts of Crop-Investment-Level on 1200-Acre Farm, North Central Montana Cash-Grain Counties.

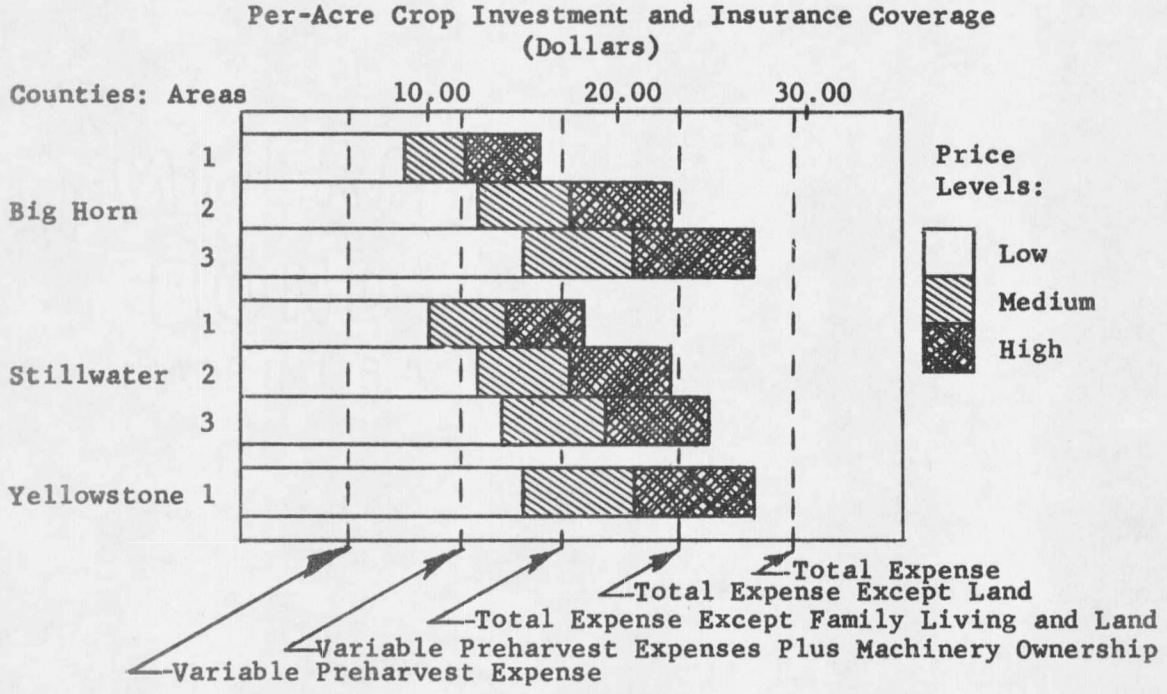

Figure 9. Federal Wheat-Crop Insurance Coverage Available at Three Price Levels, and Five Concepts of Crop-Investment-Level on 1200-Acre Farm, South Central Montana Cash-Grain Counties.

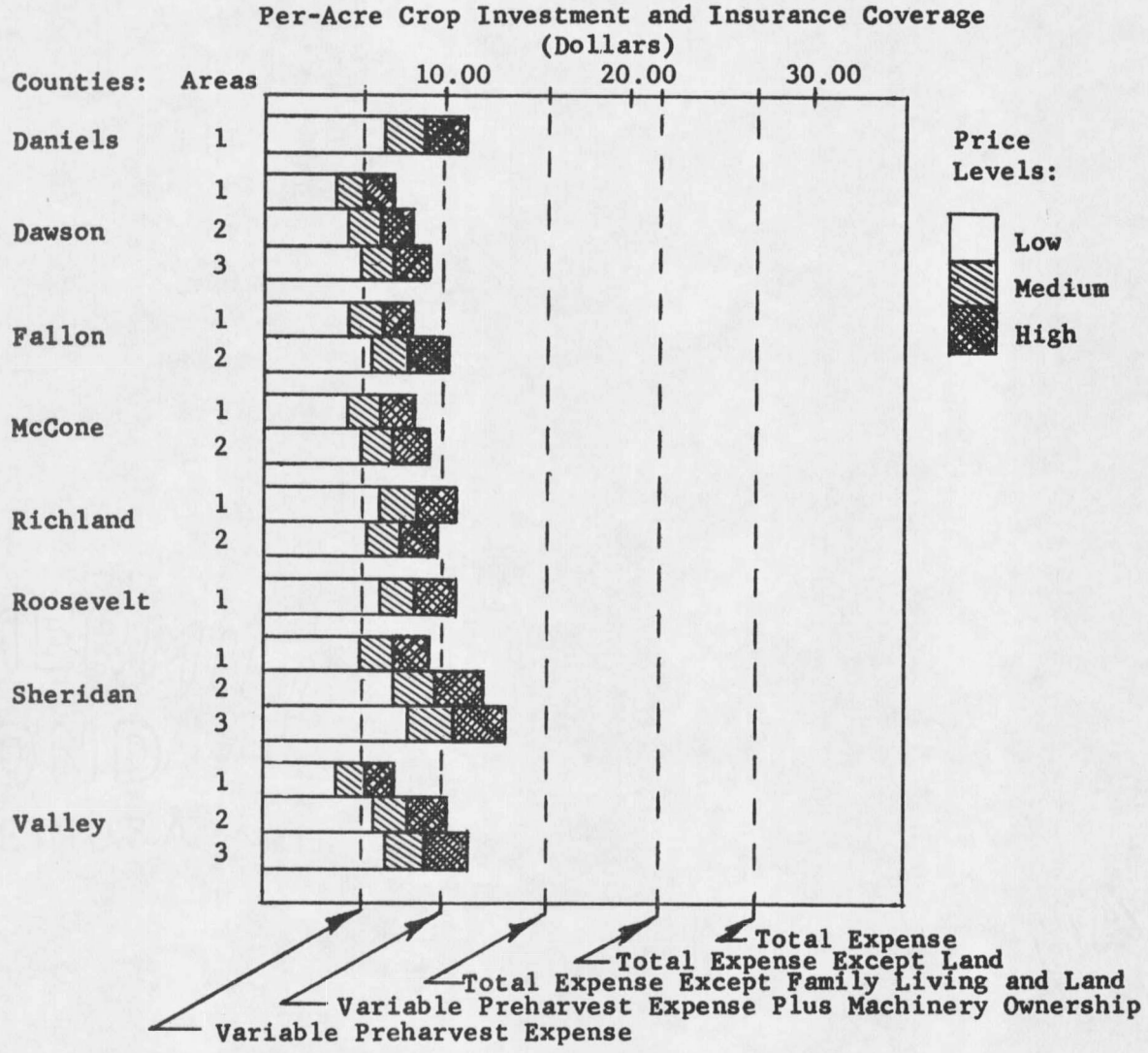

Figure 10. Federal Barley-Crop Insurance Coverage Available at Three Price Levels, and Five Concepts of Crop Investment-Level on 1200-Acre Farm, Northeastern Montana Cash Grain Counties.

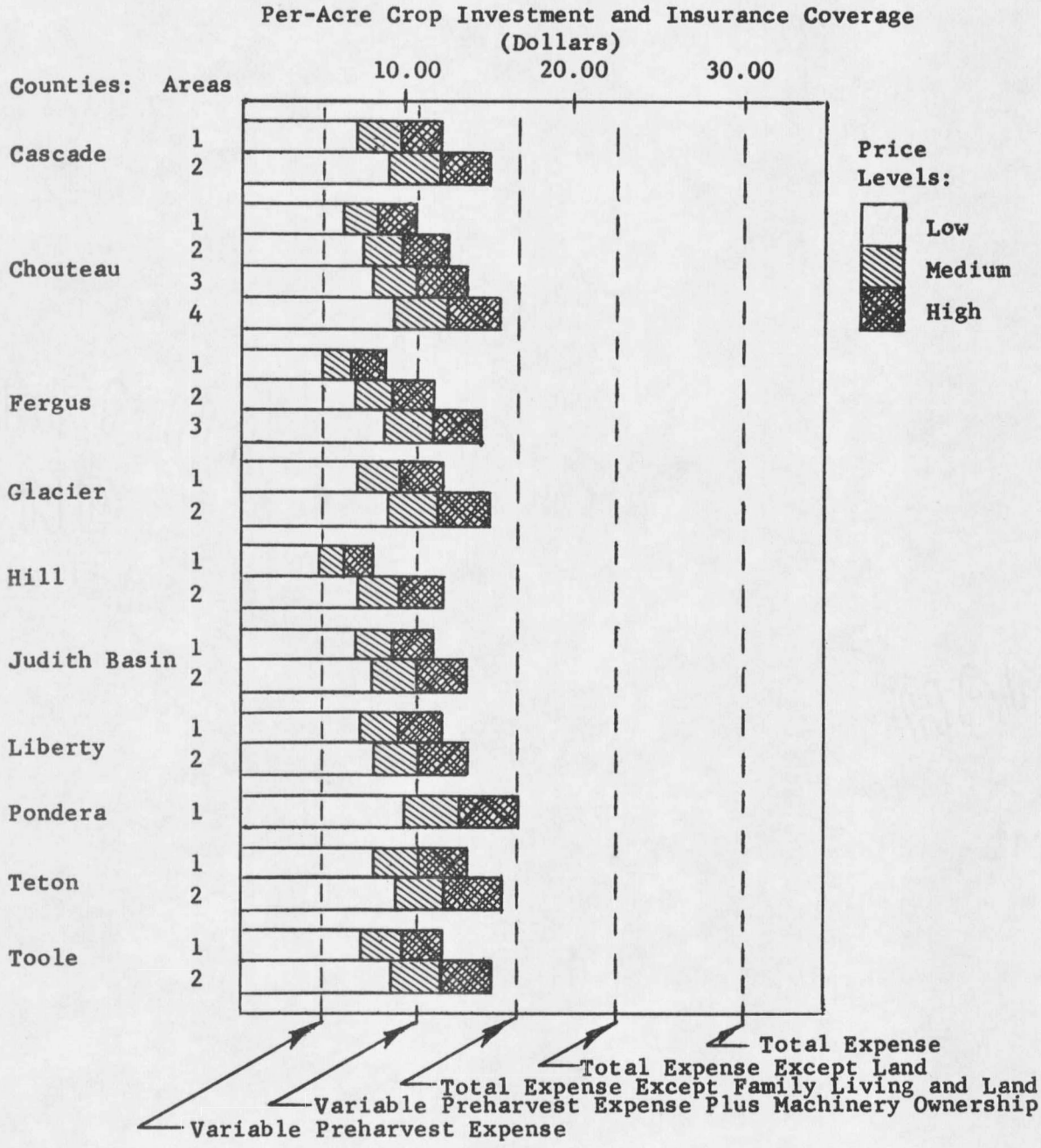

Figure 11. Federal Barley-Crop Insurance Coverage Available at Three Price Levels, and Five Concepts of Crop-Investment-Level on 1200-Acre Farm, North Central Montana Cash Grain Counties.

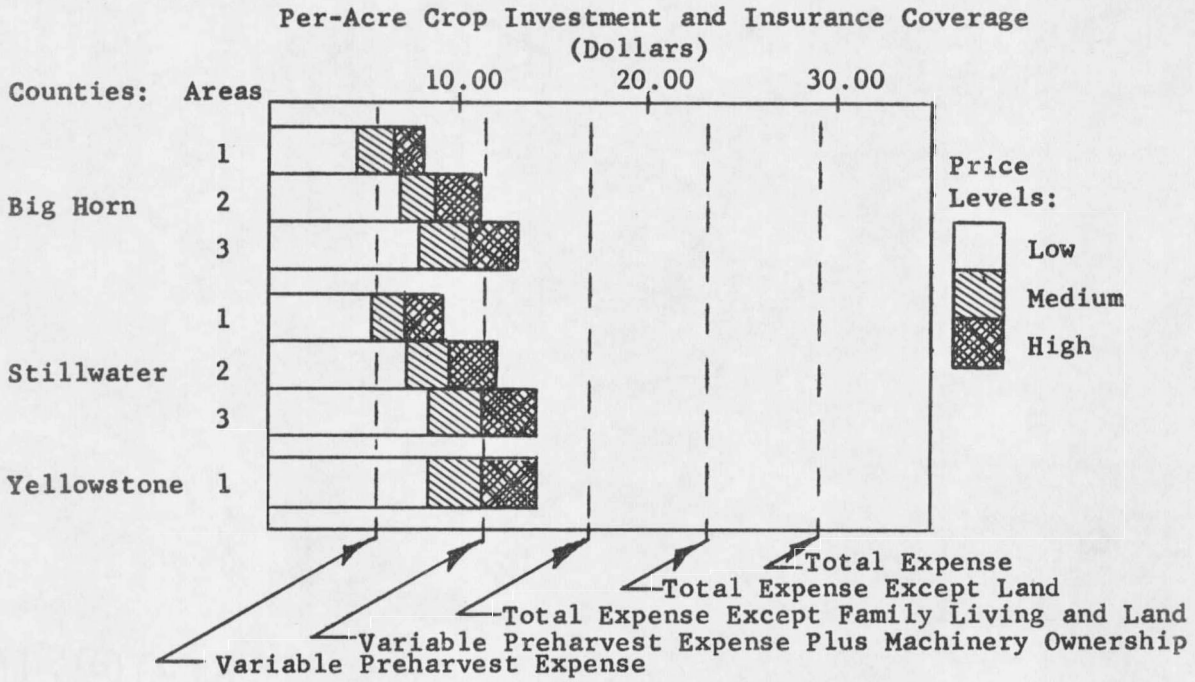

Figure 12. Federal Barley-Crop Insurance Coverage Available at Three Price Levels, and Five Concepts of Crop-Investment-Level on 1200-Acre Farm, South Central Montana Cash Grain Counties.

other counties. The lowest level of coverage was sufficient to cover variable preharvest expenses plus machinery ownership in all counties. There are only eight areas in the Northeastern counties where barley insurance is sufficient to cover even the variable preharvest expenses plus machinery ownership (see Figure 10). Thus, the coverage becomes much less adequate as cropland is shifted from wheat to barley.

The wheat coverages available in the North Central counties on a 1,200-acre farm are considerably more adequate than in the Northeastern counties (which agrees with Rodewald's conclusion). In 11 of the 22 areas, available coverage is sufficient to include family living, Figure 8. In all areas but one, coverage is available to cover total expenses except family living and land. While barley insurance does a relatively better job of covering expenses in the North Central than in the Northeastern counties, the coverage is again much less adequate than for wheat (see Figure 11).

Insurance is available in only three of the South Central area counties. For the 1,200-acre farm, available wheat coverage will protect expenses to include family living in three areas, and all but land and family living in six areas, Figure 9. Again, as in the other two cash-grain areas, barley insurance is significantly inadequate as compared with wheat. On the 1,200-acre farm, barley insurance is available to cover the variable preharvest expense plus machinery ownership in four of the seven areas, Figure 12.

The following conclusions can be drawn from this analysis with regard to adequacy of available protection:

1. Generally the available coverage on wheat is most adequate in the North Central counties, even though the costs, especially land investment, are higher. The coverage tends to be inadequate to include taxes, insurance and harvest expenses in the Northeastern area. The South Central area tends to fall between the other two.
2. The available coverage on barley is inadequate in all areas to cover family living and land costs, and in most areas to cover

much of the taxes, crop insurance, and harvest expenses besides (assuming all-barley crop).

3. The adequacy of coverage is little affected by the size of farm except as related to land cost. There were 13 areas in the North Central cash-grain area in which some or all of the land costs could be protected for the 1,700-acre farm size.
4. Apparently, if land cost can be included as a legitimate crop-investment item, there are few areas where "over-insurance" coverage should be of concern.

Summary--Coverage Levels

When considering the purchase of crop insurance, the farmer is interested in how much coverage he needs, what coverage is available, and what premium he will be charged. How much coverage he needs depends on his selection of his investment level he wants to protect. In this chapter the average costs of production in three different cash-grain areas of Montana have been classified into five stages: (1) Variable pre-harvest expenses; (2) Total pre-harvest expenses, which includes machinery ownership; (3) Total expenses less family living and land, which includes the harvest expenses, all-risk crop and hail insurance and taxes; (4) Total expenses except land, which includes family living allowance; and (5) Total expenses, which includes an allowance of 4.5 percent interest on the investment in land. The farmer can use this classification, adapt his individual situation to it, estimate how vulnerable he is or dares to be to crop loss from insurable perils, and select the appropriate coverage.

A comparison of these average costs in Montana with the appropriate coverage levels available demonstrates the degree of adequacy of coverage in various areas of the state.

Those involved with the development and administration of the Federal crop insurance program have been concerned with the "investment in the crop." The intent of the program was to cover this "investment." Also it was believed that if coverage was limited to this "investment" the moral

hazard would be minimized. This analysis defines "investment" by classifying the expense items into five meaningful levels.

The crop insurance salesman is interested in demonstrating a farmer's vulnerability to crop loss. This study provides a comparison between the five levels of investment and the yields needed to cover the various levels. Any individual farmer's situation can be adapted to the method of comparison by taking account of differences between his own situation and the average used in the study.

The following chapters will analyze the problem of premium levels.

CHAPTER VI

PREMIUM LEVELS

Premiums are a function of the crop losses caused by a number of natural and, occasionally, man-made perils. It has been noted that in the early history of all types of insurance there was a tendency to insure against specific perils, but that the evolution of different insurance coverages brought about a combining of perils under each coverage. Premium levels for each coverage then became a composite function of losses caused by each of the several perils insured against. The ultimate in what has been considered the "best" policies is the all-risk type of contract, which, rather than naming the perils insured against, names the perils that are not covered. However, even in this type of coverage, actuarially it is still necessary to segregate the most common causes of losses, and establish the probability of loss--risk--arising out of each peril. The various probabilities are combined to provide the basis for a composite premium level for the policy coverage, usually weighted for the unknown, extremely infrequent, and small unnamed loss-causing perils.

Not only must past records of losses arising out of specific perils become the basis for predicting future losses, but predictions may fall seriously in error if they are not adjusted to outside or exogenous factors that can significantly alter the perils. For this reason insurance companies segregate loss-causing perils, keep accurate records of losses caused by them, and continually study their characteristics relative to changing conditions that may affect the loss-causing potential of each peril.

Perils Insured Against

The Federal Crop Insurance policy is an all-risk type of contract with respect to weather perils, but does list the principal loss-causing perils:

> Causes of loss insured against. The insurance provided is against unavoidable loss of production due to wildlife, insect infestation, plant disease, earthquake, drought, flood, hail, wind, frost, freeze, winter-kill, lightning, fire, excessive

rain, snow, hurricane, tornado, and any other unavoidable cause of loss due to adverse weather conditions. 1/

The policy is all-risk to the extent that it covers "any other unavoidable cause of loss due to adverse weather conditions."

In Montana the most important loss-causing peril is drouth, followed in order by hail, insects, wind and winter-kill, Table XIII. Although drouth and hail are by far the most important causes of insured losses, it is important to all parties concerned that the perils be carefully analyzed according to several questions that might be answered: How is the given peril related to the other perils? How is the potential loss from each peril related to the "critical" level of production? To what extent can the potential loss from each peril be controlled by management practices? What about the relationship of changing conditons and technology to each peril? How does the understanding of each peril affect the management and insuring decisions of a farmer? What can be contributed to sales techniques from an understanding of the characteristics of the various loss-causing perils?

The proper perspective in which to view the loss-causing perils is in relation to the "critical level" of crop production. This level is defined at or near the bushel-level of coverage available to the insured in his area. Federal Crop Insurance is not concerned with crop-yield losses which do not bring the yields down below the insured levels. While this contention appears obvious, it is important enough to emphasize because, as will be pointed out later, the loss from most perils is relatively more severe when the crop is near the critical (insurance) level at the time of occurrence of the peril.

Drouth

"Drouth" in the Great Plains immediately brings to mind crop-yields that are insufficient to pay expenses, abnormal heat, dust, grasshoppers,

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1/ FCIC Wheat Endorsement, Section 1, (61-17). Same as Section 1 of Barley Endorsement.

TABLE XIII. FCIC-INSURED WHEAT CROP LOSSES BY CAUSE OF LOSS, MONTANA, 1947-1963. *

Year	Total	Drouth	Hail	Excess Moisture	Cold & Winterkill	Flood	Wind	Insects	Disease	All Other
	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
1947	5,158,753	2,594,836	1,249,396	15,675	132,524	4,493	500,927	432,436	7,153	221,319
1948	598,327	437,368	114,051	2,203			141	20,872	11,474	12,218
1949	4,018,120	3,782,908	92,436	484	15,869	115	1,464	99,991	2,641	22,212
1950	576,520	188,845	264,848	71	51,674	443	6,637	48,530	1,545	13,927
1951	890,444	381,977	358,336	37,871	29,135		13,242	16,272	896	52,715
1952	993,760	575,311	388,676		968		1,228	17,679	2,386	7,512
1953	268,898	38,057	185,589	3,634	3,302	4,320	12,136	1,669	17,131	3,060
1954	663,820	81,439	505,440	15,574	57	2,882	13,272	8,824	35,889	443
1955	127,837	764	122,699		858			2,347	57	1,112
1956	948,983	611,439	262,744	704	1,913		862	63,839	652	6,830
1957	340,998	159,336	161,673	715			370	13,017	3,720	2,167
1958	368,266	306,371	46,934				407	13,983	168	457
1959	366,300	313,268	48,751				1,182	2,731	49	319
1960	202,973	88,931	110,124			230	467	988		2,233
1961	2,149,541	1,677,526	300,315				1,732	166,432	176	3,360
1962	961,766	696,696	230,015	156	5,685	303	1,750	10,247	9,710	7,204
1963	2,784,440	2,012,258	765,324				3,048	1,597	1,847	366
TOTAL	21,419,806	13,947,330	5,207,351	77,087	241,985	12,786	558,865	921,454	95,494	357,454
% of TOTAL	100	65.1	24.3	.4	1.1	.1	2.6	4.3	.4	1.7

* Source: FCIC County Analysis Sheet 3, Montana, May 31, 1964.

difficulty in tillage operations, and particularly anxiety as to whether the adverse conditions will continue. Drouth is a relative term, meaning different things to people of different parts of the country, and especially to people of different parts of the world. To many people of the world, drouth is synonymous with famine. But in the United States, drouth is associated with economic distress, inconvenience, anxiety about the future, and interference with affluency:

> The United States is well-fed. That is because a considerable part of our country nearly always gets plenty of rain. . . . Under normal conditions we produce more food than we need; nevertheless, drought has serious consequences. Any important widespread deficiency of rainfall in the United States, even for only a year or two, strikes at the very foundation of our national security as does nothing else except war or revolution. This fact has been impressed on us twice within the last sixty years when, in the depth of national depression, we were severely shocked by what we thought at the time was a broad-scale change to a drier climate. 2/

What would be considered a drouth in one region of the United States would not be a drouth in another region. A deficiency of rainfall in one year which results in a shortage of water for domestic and commercial use in the industrial East is considered a drouth in that region, while the same amount of rainfall would produce a bumper crop in the Great Plains. Also, the same relative deficiency for only one year in the Great Plains would be expected and considered just a random dry year. In the Great Plains just one abnormally dry year does not necessarily constitute a drouth--it is the bunching, wide geographic distribution, and seasonal occurrence that constitutes a drouth in the Plains, as contrasted with the humid East, where one deficient year is seldom expected and consequently may be catastrophic.

Annual rainfall records provide the only precise measurement of drouth available. Yet this measurement falls far short of providing a

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2/ Tannehill, Ivan Ray, Drought--Its Cause and Effects, Princeton Univ. Press, Princeton, 1947, page 10.

definition that is compatible with actual drouth conditions. For instance, in a given locality, the weather records show some years that would indicate drouth conditions; yet, because of the timing of the moisture, or because of favorable moisture storage conditions the year before, the figures on crop yields, and other measures of drouth may not indicate serious results of the subnormal rainfall. Tannehill points up the problem when he says:

> There is always the question of rainfall prior to the drought. It has happened frequently that a local drought has been preceded by rainfall considerably above the average. In other cases the drought has been preceded by another period of deficient rainfall. Subnormal soil moisture, high temperatures, strong wind movement, and excessive evaporation make a moderate deficiency of rainfall more serious than a large deficiency under other circumstances.
>
> . . . . . .
>
> Sometimes we scarcely recognize a local drought when we see it in the rainfall records. When the student of weather records begins to make a study of local droughts in the United States he becomes badly confused. He is confronted with the tremendous task of working all the records over again to fit his ideas of what a drought really is, or he is obliged to accept data which appear to be in a state of disorder so far as his particular problem is concerned. . . .
>
> From these facts we gather that it is useless to attempt to give a precise definition of drought. . . . 3/

For purposes of this study on crop insurance, drouth can be defined relative to two interests: (1) That of the FCIC, where the problem is that of formulating premiums which will cover indemnities over some predetermined period. Here the question is how long a period should be chosen and what drouths can be expected during that period. (2) That of the insured, where the problem is making decisions as to whether he can take a chance on the occurrence of drouth, or whether he should build reserves against the risk of drouth, or whether he should exchange his weather uncertainty for an insurance premium. Therefore, in this study, which is primarily

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3/ Ibid., pp. 38-39.

related to Montana and the Great Plains, a general drouth should be defined as a period of at least two consecutive years of moisture conditions such that crop yields are generally sufficiently low in the region under consideration to impare the capital investment of a majority of the operators. This is necessarily a very broad definition, and means different things to different operators. But generally it implies a serious forced reduction of net assets in one way or another, and for some operators, a liquidation of their firm. For some, it means drawing down reserves, others an increase in indebtedness, and for still others bankruptcy.

However, "drouth" will also be used in a short-term, more specific sense when it refers to rainfall situations that tend to reduce yields seriously below normal or average, or below the "critical" level, defined approximately as the insured yield level. The context will indicate whether the general or more specific short-term definition is applicable.

The reason why drouth is the most important cause of insured losses in Montana and the Great Plains is obvious to the natives thereof: The average rainfall is extremely variable about a mean which is at or near the critical level for crop production. The result is extreme variability of yields--from complete crop failure to yields as high as can be obtained in humid areas or under irrigation. Kraenzel points out that the semiarid condition of the Great Plains is unique--that the climate is not halfway between humid and arid:

> Instead, the Plains are a semiarid land. They are not semiarid in that the climate is halfway between humid and arid. They are not half dry and half wet; rather, some years they are dry and even arid; other years they are very wet; and still other years are wet or dry at the wrong times from the standpoint of agricultural production and yields. It is this undefinable aspect of semiaridity that gives the Plains their distinctiveness. 4/

He further adds:

> The significant thing for the Plains region is the low average crop season rainfall, at or below the margin of successful

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4/ Kraenzel, Carl F., The Great Plains in Transition, U. of Oklahoma Press, 1955, page 12.

> agriculture as practiced under humid-area conditions. In short, the cropping practices change from a humid to a dry-land system. Coupled with this is the great variation in growing-season precipitation from year to year and within the same year. Almost everywhere the driest year brings less than ten inches of rainfall, and the wettest brings more than three times the lowest amount. This makes the seasonality of the rainfall almost as important as the amount in order to have reasonable yields. It places a premium on field and range practices that cut down on moisture runoff and evaporation.
>
> These critical conditions of variability and seasonality are further intensified by the unpredictable occurrence of the precipitation. If the variations were predictable, adjustments in the way of living might be readily made. The added fact of unpredictability increases the climatic hazard significantly. 5/

Thus, the very uniqueness of the Great Plains climate makes drouth a vital factor, particularly when the crop, for any reason, gets off to a poor start in the beginning of the season. In other words, if the crop is already at or near the critical level when hit by a long dry period, it can quickly be turned into a crop failure. Whereas, if the crop is strong, and if there is some storage of moisture, a long dry period may considerably reduce the yield, but not enough to require an insurance indemnity. For this reason good management practices are effective in materially reducing insurance losses.

Drouth has another peculiar characteristic that is important to recognize--it has an important bearing on the degree of loss from the other perils. For instance, the incidence of destructive hail storms may be related to whether or not the year is wet or dry, in any given area of the state. The author was not able to find conclusive evidence of correlation between rainfall and hail; however, local humid conditions are necessary for thunderstorm activity which is necessary to produce hail. Trewartha lists the prerequisites of thunderstorms as (a) warm, moist unstable air; (b) an appreciable cloud thickness between condensation level (cloud base) and icing level; and (c) an agent to set off the activity by rendering the air unstable at some level. Regarding hail, he says:

5/ Ibid., page 17.

> Occasionally hail, the most destructive form of precipitation, is developed in very intense thunderstorms. Fortunately it occurs in only a few, and usually it falls in only restricted areas or belts within any individual storm. It appears to be associated only with particular cells within the thunderstorm rather than with the entire storm. 6/

While on the one hand drouth may be associated with a lower incidence of hail, the damage from a hail storm of given intensity may be relatively more destructive to poor crops than to good crops. A storm that would destroy 75 percent of a crop would leave 10 bushels of a 40-bushel yield, while it would leave only 2½ bushels of a 10-bushel yield. The former would require no insurance indemnity, while the latter would be a complete insured loss. Also the author observed in his years on a dryland wheat farm in Montana that apparently part of the grain in a heavy crop was protected from damage in partially destructive storms by overlaying heads and straw. If the accompanying wind layed the heavy grain down, some of the broken heads could be saved. In other words it always appeared that the percentage damage from a storm of given intensity was higher on the poorer crops.

Drouth losses are also related to insect damage, particularly damage caused by grasshoppers. As in the case of hail, the relative damage from insects is more serious at the critical yield level than in a heavy crop. An infestation of grasshoppers that would consume 10 bushels per acre of grain would leave 30 bushels of a 40-bushel crop, but would totally destroy a 10-bushel crop, resulting in a 100-percent insurance indemnity.

There are other factors involved that tend to increase the grasshopper loss in drouth years. When the grass surrounding crop areas is shorter and dries out sooner, more of the grasshoppers are forced to migrate and at an earlier stage, seeking the usually greener wheat.

Drouth is also related to loss from winterkill in the winter wheat areas. It is often difficult to decide whether a winter wheat crop was

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6/ Trewartha, Glenn T., An Introduction to Climate, McGraw-Hill, New York, 1954 (Third Edition), page 211.

"winterkilled" because of low temperatures, or because of dry weather or lack of snow cover at crucial times. The latter would be a case of low temperatures combined with dry weather. Observations of crop damage during the winters when the author lived on the farm indicated that the only time wheat was killed by low temperatures was when the land was bare and the temperature was about 30 degrees or more below zero. This occurred in only three years in the past fifty. A more common cause of loss appeared to be either a poor stand of weak plants in the fall due to drouth, or a drying-out process when the plants were weak early in the spring, before the new roots were well developed. This drying situation in the spring also appeared to be related to foot rot--the wheat plant appeared to be too weak and dry to make new growth and to slough off the dead and mouldy part of the plant. The plants tended to be yellow and weak, unless good rains and warm weather were forthcoming early in the development of the plants in the spring.

Finally, drouth is related in some way to wind damage to crops. Usually in the Great Plains wind damage is thought of as direct damage to the crop such as breaking the plants and shattering of the heads. However, in addition to this type of damage, the winds associated with drouth apparently are different and more destructive than those prevalent in wetter years. Tannehill says:

> The damaging effects of drought are due not only to the lack of rain, but to the drying effects of winds, usually warm or hot winds which frequently prevail when rainfall is seriously deficient. Vegetation already deprived of needed moisture is subjected in addition to the desiccating action of dry winds under cloudless skies. In colder latitudes agriculture prospers with much less rainfall than is needed in warmer latitudes because evaporation goes on at a much slower pace. The principal point here is that the circulation of the atmosphere is different in drought years from that in years with normal or above-normal rainfall. 7/

Summarizing, it is concluded that drouth is closely related to other crop perils, and that in many cases it is difficult to determine if a crop

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7/ Tannehill, op. cit., page 51.

loss is entirely due to drouth, and if not, what proportion is due to drouth and what proportion to other loss-causing factors, such as hail, insects, disease, winterkill, or other. Only two of the other perils are possibly affected favorably by drouth: The incidence of hail and disease, such as rust. The relative damage from hail is affected adversely by drouth, as are the results from insects, winterkill, and wind. Since drouth is the primary cause of loss in the Great Plains, the last sections of this chapter will concentrate on drouth more heavily than the other loss-causing perils.

Hail

Hail, the peril second in importance as a cause of indemnified loss in the Great Plains, is the one peril over which a farmer essentially has no control. His only influence on loss is by the use of varieties which may not shatter as easily in wind or hail, and this is a factor only when the crop is nearly ripe. Since hail occurs in relatively small strips, the dispersion of his crops undoubtedly has some effect--the more widely dispersed, the less the proportion of the crop likely to be damaged. Evidence of the wide variation in occurrence of hail in Montana is the variation in premium rates over the State: For the state as a whole, the rates on wheat range from 4.0 percent of the insured value in some of the western counties to 12.4 percent in counties east of the Divide. Within some counties the rates vary considerably: Judith Basin, 6.6 to 12.4 percent; Blaine, 6.4 to 12.0 percent; and Sweet Grass, 6.4 to 12.0 percent. Not only does the variation in rates indicate considerable variation in hail frequency within the State, but also indicates that hail storms follow geographic patterns. Two of the most catastrophic storms in the State in recent years hit Billings within two years of each other. The author was told by a Great Falls insurance underwriter recently that several of the larger insurance companies will no longer write hail damage coverage in Billings because of the frequency of heavy losses.

The localized nature of hail damage, and the tendency of hail storms to repeat in the same localities or along the same paths over a period of

years is important in crop insurance rating. Therefore, a brief description of hail storms is appropriate to this study.

Hail owes its localized nature to the fact that it is born in only a relatively few thunderstorms, and only in particular cells within any given thunderstorm. The formation of hail itself requires a complex set of factors, including moist air, a vigorous convection system, and appropriate temperatures in the various storm levels. Fortunately, it is relatively rare that all these factors are present, and hence the local and regional variations in the frequency of hail:

> The regional and local variations in the frequency of hail and in the amount of hail damage are startling. It should be noted that hail frequency and thunderstorm frequency do not show the same distribution. Hail is practically unknown in the tropics where thunderstorms are most numerous. Within the United States thunderstorms are most frequent in the subtropical southeastern part, especially in Florida and the Gulf Coast, but this is a region of almost no hail. Hail frequency is greatest over the interior of the country, more particularly over portions of the Rocky Mountains and the Great Plains where newly formed intense showers are relatively frequent. 8/

A description of what causes hail, written in the Montana Farmer-Stockman after the 1956 Billings hailstorm, gives a clue as to why hailstorms have some tendency to follow a geographic pattern:

> Two conditions are necessary for thunderstorms and hail: moisture and turbulent, unstable air.
>
> Water vapor is always present in the atmosphere in varying amounts. It's the amount of water vapor that determines the intensity of rainfall or the size of hailstones. Thunderstorms are usually preceded by warm, southerly winds which originate in the tropics and carry a high percentage of water vapor.
>
> Several factors can cause the air to be unstable. A layer of surface air may be heated by the sun and sent skyward. If the air aloft is comparatively cold, the rate of ascent will be greatly increased. River valleys and mountains will deflect air currents frequently, causing them to converge and adding to the turbulence. . . . 9/

8/ Trewartha, op. cit., page 211.

9/ Ozmon, Ray, "What Causes Hail?" Montana Farmer-Stockman, July 1, 1956, page 1. (Underscoring by author) See Appendix D for complete article.

If surface features such as river valleys and mountains can have an appreciable effect on adding instability to the air currents, it is conceivable that these features also have an effect upon where the hailstorms will occur most frequently.

It should be emphasized that hailstorms only tend to follow geographic patterns--they can and do occur where there is no record of having hailed before. Strange and completely unfamiliar characteristics are sometimes noted in hailstorms. For instance, the usual direction for the approach of hailstorms to Square Butte Bench in Southeastern Chouteau County is in an easterly direction. Two years ago a devastating storm swept across a section of the Bench toward the south and southwest. In 1932, a severe storm crossed the Bench toward the North. Practically all the thunderstorms west of the Divide in Montana travel in an easterly direction; the exceptions appear to involve hail.

All these various characteristics of hailstorms are important to the problem of improving the crop insurance program, as will be pointed out in subsequent sections of this chapter. Regional and local variations in the frequency of hail are pronounced. The storms tend to follow a geographic pattern, but no area in the Great Plains can be considered immune from the peril because of the erratic behavior of hailstorms.

Insects

Damage by insects is the third-ranking cause of loss indemnified by the FCIC. In checking with the Montana state office of FCIC the author was informed that, in reporting claims, only the predominate cause of loss is indicated. Therefore the statistical record under-reports the actual loss caused by insects. As noted above, grasshopper damage would probably be included as a drouth loss in a year where the predominate cause of loss is drouth. In 1962 the author observed the adjustment of a claim near Shelby, Montana, where the total crop loss was predominantly due to drouth, but in some fields as much as half of the remaining crop was cut off by sawflies. The total loss was reported as drouth-caused.

The important consideration with respect to the insect peril is that it can now be controlled better than most other perils. The grasshopper menace was previously one of the worst crop perils, especially in drouth years. Now it can be effectively controlled by sprays. Therefore, the insured's management can make a significant difference. Sawfly can be controlled by the development and use of resistant varieties, and proper cultural practices. There are some insect-carried diseases, such as wheat streak mosaic, which is controllable to some extent by cultural practices, but has been known to cause extremely heavy crop losses in the southern Great Plains, and recently has appeared in Montana.

Summary--Perils Insured Against

Drouth is by far the most important cause of crop loss in Montana. Because it is the primary peril, and because loss reports show only the predominant cause of loss, other causes such as hail, wind, winterkill, and insects are under-reported. It was shown that wind, winterkill, and insects in particular are related to the drouth peril in that they are relatively much more serious in drouth years. While the incidence of hail may be less in drouth years, its relative effect on crops may be much more critical when it does occur.

The main point in understanding the characteristics of the perils is that management practices are effective in controlling some of them to some degree, and become relatively much more effective as crop production drops toward the "critical level"--the level below which indemnities would be paid. The FCIC's concern is that if agents are aware of these peril characteristics and how much effect cultural practices have on resulting losses, insureds can be more carefully checked and helped with respect to prevention of losses. This knowledge would provide better underwriting guides, and form a sounder basis for experience credits, as discussed in Chapter VII.

Further, FCIC must make rate projections. It therefore must know what developments are taking place which will affect the different perils. For instance, as soon as an effective spray for controlling grasshoppers

was put on the market, the FCIC could have adjusted premiums accordingly, had they known accurately what part of drouth losses were actually due to grasshopper damage. Likewise, the FCIC should know where new outbreaks of new diseases are occurring, how rapidly they might spread, and how serious they could be, especially in drouth years.

When new technology is available that would decrease the chance of loss from any perils, it is not only important for the FCIC to adjust its rates accordingly, but also it may be able to quickly inform its insureds of the new development, and thus cut down losses more rapidly.

The conclusion is that it may pay to learn more about individual crop perils, even though the record of losses does not show some of the perils to have been of much importance. Some of the perils may be of more importance than indicated on the record. Further there is no guarantee that some disease or insect outbreak will not be considerably more serious than drouth. For example a recent news article in the Wall Street Journal:

> FARM BELT MENACE--CORN VIRUS DEVASTATES THOUSANDS OF ACRES IN MIDDLE WEST AND SOUTH--New Disease Defies Control Efforts; Experts Worried Over Future Crop Impact--Search for Resistant Hybrids--Friendship, Ohio--Standing beside his hill top farm home, grey-haired Farrell Vaughters gazes out over 500 acres of fertile Ohio River Valley land, where most summers he sees lush green corn that towers two feet above a six-foot man.
>
> But now he sweeps a suntanned arm at a valley of dwarfed, hip-high corn, its leaves weirdly streaked with bright red, purple, and yellow and its ears gnarled and sparsely kerneled. "I've farmed this valley for more than 50 years and that, by far, is the worst crop disease I've ever seen," he observes gloomily.
>
> Mr. Vaughter's crop has corn virus, a new disease in the Midwest and the first major threat to the Corn Belt since the corn borer invaded the land more than 30 years ago. While his Ohio farm is an extreme example of the current damage from the virus, Mr. Vaughter's concern is shared by many farm experts, including those of the U.S. Department of Agriculture. 10/

10/ Slocum, K. G., The Wall Street Journal, Sept. 1, 1964, page 1, Col. 1.

Randomness of Perils

The discussion in Chapter II pointed out the ideal requirements for insurability, and also pointed out that most insurance falls short of the requirements to some degree. The more closely a given insurance program adheres to the ideal requirements, the more accurately can the premiums be established. One of the important requirements is that the actuarial period and area must be such that a maximum of randomness in the occurrence of loss-causing perils is achieved. A basic problem of Federal crop insurance, then, is the characteristics of the various crop perils with respect to randomness of occurrence. The two principal perils, drouth and hail, will be examined relative to their randomness of occurrence.

Drouth

Because the cause of the largest portion of indemnity payments in the Plains is drouth, the randomness of occurrence of dry years is a major factor in accurately predicing loss expectancy. Randomness of natural events such as weather is considered in two ways--(1) geographically within the annual premium time period, or (2) over a period of time chosen for actuarial prediction purposes.

Geographic Randomness.--Two approaches can be used to substantiate the lack of randomness in the occurrence of dry years in the Great Plains: (1) The one that will be discussed first is related to the meteorological weather pattern of the Great Plains--what causes alternating drouth conditions and high precipitation in the Plains; (2) The other approach is to examine weather records.

A few quotations from Tannehill tell the characteristics of weather in the Great Plains, why drouth is likely to be widespread over the Plains, and where the Plains weather is "made":

> We talk of rainfall over the nation as a whole. What does that mean so far as the Great Plains are concerned? . . . In general, we can give the same kind of answer that politicians formerly gave in predicting the outcome of national elections, "As Maine goes, so goes the nation." And we can confidently say in regard to rainfall, "As the Nation goes, so go the Great Plains."

> . . . of the three great divisions of the country, none reflects the national trends as well as the great middle region from the Mississippi to the Rockies.
>
> If we use the records of individual places as an indication of rainfall in any region we get into trouble. There are all sorts of local variations. A single thunderstorm could hover over a rain gage in a semi-arid region and produce a rain measurement that would take years to smooth out in the averages. It is not reasonable to conclude that we can use the catch of a single rain gage in this vast trans-Mississippi territory to indicate the variations of rainfall for the entire region. But in the long run the great Pacific Ocean in its relation to the changes in the relative position and heat of the sun is the deciding factor. There is no place in the trans-Mississippi region where the farmer can get away from that powerful influences. 11/

Though the weather of the region is influenced by the Pacific Ocean, the weather of the northern half of the Plains is sometimes the opposite of the souther half:

> The Great Plains, lying just east of the Rocky Mountains, are more strongly under Pacific control than any part of the United States except the area between the mountains and the Coast. The Dakotas and that part of Montana which is east of the mountains form a broad channel through which cold or cool air masses enter this country from Canada. During the winter, and at other times when these dry northerly winds blow across this area and moist winds are blocked farther southward, the northern part of the Great Plains may be dry while the southern Great Plains may get some rain. But the hot winds of summer and warm dry winds at other seasons enter the Great Plains from the Southwest, and that region may be dry while moist winds, especially in June or July, may reach far to the northwest and bring some rain in the Dakotas and eastern Montana. This is a mechanism which gives us a strongly seasonal oscillation in rainfall between the northern and southern parts of the plains region. 12/

There are times, too, when the Atlantic has a strong influence on the precipitation in the Plains. Tannehill says that while the Pacific controls the amount of rainfall over the United States, the Atlantic tends to control its distribution:

11/ Tannehill, op. cit., pp. 107-108.

12/ Ibid., pp. 111-112.

> The long-term rain-distribution influences of the Atlantic and Gulf on the one hand, and the Pacific on the other hand, cannot be separated clearly. 13/

Tannehill also draws conclusions regarding weather cycles, relating them to his sunspot theory of weather variations and to studies of tree rings. His discussion gives credence to the observations of some writers that there is a tendency toward "bunchiness" of dry years. Tannehill says:

> There is good reason to look for a national dry year about once every five or six years. When rainfall tends to be generally deficient, we have two or more dry years in one spell; and when rainfall is generally heavy, the drought is less serious. 14/

The evidence appears to be conclusive that occasional periods of widespread drouth can be expected, but with no predictable regularity. When they do occur, they are likely to cover at least half the Great Plains, and sometimes the entire country. Tannehill puts the Plains in perspective, weatherwise, when he writes:

> When compared to the great stretch of oceans from the east coast of Asia to the west coast of Europe, the continent of North America seems to be little more than a large island. The prevailing west-to-east winds of the Northern Hemisphere sweep across this vast sea area, powered by the sun's heat and modified by the changing seasonal contrasts between continent and oceans. 15/

Thus, the Great Plains is seen as an island over which the vast worldwide storm patterns move, where there are small random weather variations within large general weather patterns. It can be concluded that as concerns the geographic randomness of drouth, the small weather variations between small areas such as counties may be independent within a given year. Drouths covering large areas may be expected occasionally, resulting from changes in the major weather patterns of the entire hemisphere. If the latter are to be treated actuarily, the actuarial rate-making period must be long enough to cover a complete cycle based on some method of prediction.

13/ Ibid., page 119.

14/ Ibid., page 161.

15/ Ibid., page 78.

Weather records tend to substantiate the lack of geographic randomness, and as expected, the larger the region under consideration, the greater the randomness--the less likely a drouth year would occur generally to the whole region.

Annual rainfall was analyzed for 10 Montana weather stations and 2 stations representing the cash-grain areas in each of nine other Plains states. Table XIV lists the annual rainfall and the mean annual rainfall for each of the 28 stations, from 1920 to 1962. The correlation of annual precipitation between each pair of stations was calculated as a measure of the geographic randomness of annual rainfall over Montana and the Great Plains. Based on the 43 years of observations, the probability is at least 95 percent that precipitation variability between two stations is not random if r is greater than + .302 or is less than - .302. 16/ Table XV shows the correlation coefficients between every pair of the selected stations.

As one would expect, there is a significant degree of correlation between stations in Montana. Out of 45 pairs, all but 12 correlations are significant at the 95 percent level. The coefficients of 17 pairs were more than .500. On the other hand, it is noted that there are some relatively low correlations, such as between Cut Bank and Moccasin, and Cut Bank and Billings, where r was .079 and .083, respectively. This phenomena could be due to two different factors: (1) As Tannehill observed, one local storm could produce a rain measurement that would take years to smooth out in the average. Thus, the low correlation could be due to local random occurrences. (2) Cut Bank is close to the east face of the Rocky Mountains and on the west edge of the Canadian storm channel, while Billings and Miles City are much closer to the center of the Plains area. Therefore Cut Bank weather may be dominated by different general storm movements. The correlations of Cut Bank with Conrad and Great Falls (which

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16/ Freund, John E., Modern Elementary Statistics, Prentice-Hall, Englewood Cliffs, 1960, page 337: Using formula $Z = r\sqrt{n-1}$, where at a confidence level of 95 percent $z = 1.96$, and $n = 43$, r is calculated to be $\pm$ .302.

TABLE XIV. ANNUAL PRECIPITATION: SELECTED STATIONS IN GREAT PLAINS STATES, 1920-1962. *

	MONTANA						
Year	Billings	Cut Bank	Geraldine	Glendive	Great Falls	Havre	Poplar
	In.	In.	In.	In.	In.	In.	In.
1920	10.31	7.45	16.32	13.51	12.17	14.14	10.07
1921	11.13	8.89	18.22	12.42	14.34	13.03	15.68
1922	14.63	10.50	14.29	13.43	14.66	12.25	13.31
1923	10.66	14.21	16.86	16.28	20.45	17.78	15.34
1924	11.74	14.36	12.04	13.40	14.09	14.45	10.14
1925	14.43	13.40	14.17	14.80	14.93	18.50	12.00
1926	9.43	11.77	10.45	10.16	13.29	11.53	8.79
1927	17.47	20.99	16.98	18.92	20.74	19.01	16.82
1928	11.96	13.24	11.59	11.53	13.86	10.89	11.31
1929	10.69	10.74	14.71	14.93	13.64	10.99	9.35
1930	9.22	12.21	9.29	12.76	11.61	8.73	11.81
1931	8.21	9.24	10.63	9.14	11.24	8.50	6.79
1932	18.34	14.17	17.28	16.80	19.38	15.31	15.91
1933	13.16	8.60	14.71	14.70	16.25	14.19	13.85
1934	8.68	12.32	10.83	4.83	14.03	10.26	6.37
1935	11.14	5.36	8.20	14.18	7.45	8.53	13.39
1936	9.20	12.01	8.21	9.19	9.16	8.52	7.87
1937	14.37	11.15	11.09	10.52	9.66	11.12	8.98
1938	18.69	13.59	16.65	12.54	14.84	17.10	16.38
1939	11.72	8.17	12.83	10.59	9.89	9.54	13.73
1940	13.50	12.59	13.81	14.98	12.09	15.16	12.78
1941	18.80	11.04	17.67	13.69	17.64	13.56	14.03
1942	16.34	12.87	16.21	19.21	14.55	13.52	12.97
1943	11.92	9.50	16.56	14.81	13.96	11.29	16.12
1944	15.44	7.53	15.81	15.67	14.21	10.28	13.52
1945	10.86	11.97	14.22	12.89	13.51	12.93	11.91
1946	11.80	14.24	13.03	15.71	13.98	9.58	18.94
1947	12.72	13.00	13.14	18.19	12.35	10.94	15.67
1948	7.90	15.67	16.73	13.76	16.39	9.14	13.49
1949	15.26	9.86	12.03	8.28	11.67	8.87	6.85
1950	13.76	9.23	15.71	18.06	16.55	13.49	14.40
1951	11.99	17.28	20.01	9.90	21.59	17.04	10.43
1952	10.79	8.34	9.39	8.37	9.02	7.34	9.56
1953	11.70	16.08	20.62	16.67	20.75	14.02	20.31
1954	11.75	10.23	21.09	12.97	15.68	13.94	15.33
1955	19.89	10.89	14.71	10.63	19.65	16.01	14.36
1956	10.58	16.65	10.52	11.46	10.76	9.33	14.48
1957	21.22	8.67	19.13	15.91	16.16	11.65	8.76
1958	16.74	15.16	16.87	10.17	16.14	11.15	7.75
1959	11.60	12.26	18.39	9.22	13.63	13.35	12.36
1960	9.39	8.15	12.55	8.58	9.81	10.66	10.57
1961	13.52	10.63	11.98	12.48	10.48	7.43	10.39
1962	14.22	9.85	20.10	17.36	15.95	11.59	17.82
TOTAL	556.87	504.06	625.63	563.60	612.20	526.64	540.69
MEAN	12.95	11.72	14.55	13.11	14.24	12.25	12.57

TABLE XIV. (Cont.) ANNUAL PRECIPITATION: SELECTED STATIONS IN GREAT PLAINS STATES, 1920-1962.*

Year	MONTANA (cont.)			KANSAS		COLORADO	
	Conrad	Miles City	Moccasin	Garden City	Hays	Fort Morgan	Lamar
	In.	In.	In.	In.	In.	In.	In.
1920	12.15	12.97	18.36	21.61	21.28	12.80	14.53
1921	8.81	17.47	15.48	21.48	18.46	11.61	17.89
1922	12.28	15.86	15.38	16.89	18.98	11.75	10.80
1923	14.79	16.99	18.58	34.81	27.10	14.54	23.58
1924	12.20	9.34	12.14	14.23	14.51	10.78	13.75
1925	17.29	12.00	13.50	13.81	23.02	12.18	16.67
1926	8.83	9.88	14.79	18.00	16.45	11.98	12.60
1927	16.61	18.56	16.09	12.81	27.21	15.20	20.21
1928	12.65	12.35	12.21	28.24	29.94	14.12	20.11
1929	9.66	13.79	13.28	18.30	26.57	15.71	14.98
1930	12.02	10.38	12.18	23.04	25.03	12.77	18.33
1931	8.57	6.18	10.71	17.73	26.06	10.09	7.73
1932	8.86	15.03	15.59	16.25	31.66	10.96	12.35
1933	10.59[a]	10.24	15.79	18.24	16.26	14.70	12.67
1934	14.55	5.51	10.17	9.08	16.06	6.41	9.16
1935	7.26	11.54	9.89	9.56	21.87	16.46	8.97
1936	7.62	6.06	10.10	14.12	15.90	14.55	11.27
1937	12.90	10.42	9.58	8.87	17.86	9.91	7.67
1938	13.97	10.84	14.63	15.44	22.11	13.20	17.69
1939	8.31	9.16	12.00	10.45	15.85	5.15	9.68
1940	15.06	14.40	11.99	21.50	22.91	11.12	15.04
1941	19.48	18.07	17.35	26.79	28.13	14.29	22.07
1942	14.01	15.66	19.61	20.74	29.61	18.57	20.88
1943	17.73	15.01	14.43	14.40	16.19	10.99	10.09
1944	9.70	18.95	18.10	27.21	29.70	11.30	21.94
1945	10.53	12.60	16.31	15.17	20.29	18.61	15.69
1946	12.78	17.80	18.26	28.13[b]	26.48	17.42	24.51
1947	11.07	11.88	15.39	17.36	22.65	13.76	12.51
1948	16.06	16.08	16.55	16.61	26.19	12.57	12.48
1949	9.81	8.79	12.87	21.48	23.62	15.10	21.56
1950	13.16	13.66	16.29	23.05[c]	25.59	9.45	15.42
1951	16.21	14.91	12.63	28.44	43.34	13.69	17.15
1952	7.69	9.86	9.76	10.29	13.39	10.75	9.51
1953	16.56	16.61	15.09	13.99	21.07	14.51	14.01
1954	12.49	10.38	15.61	15.15	18.56	10.97	10.23
1955	12.44	13.06	13.78	19.73	21.16	13.37	10.09
1956	11.52	9.55	10.01	18.15	9.21	15.38	13.99
1957	10.97	12.62	13.92	21.36	28.33	14.74	18.12
1958	14.00	13.22	11.62	28.37	31.21	15.54	16.30
1959	13.01	9.48	16.06	18.07	24.43	12.09	13.38
1960	6.87	6.99	9.32	16.63	20.47	9.77	14.06
1961	9.22	9.97	12.51	19.39	28.31	15.61	16.70
1962	5.80	19.00	20.64	18.64	23.09	14.12	12.92
TOTAL	516.09	541.08	608.55	803.61	986.11	558.59	639.29
MEAN	12.00	12.63	14.15	18.69	22.93	12.99	14.87

a/ One month missing, was estimated at mean for particular month.

b/ Used Lakin for 1946.

c/ Used Cimeron for 1950.

TABLE XIV. (Cont.) ANNUAL PRECIPITATION: SELECTED STATIONS IN GREAT PLAINS STATES, 1920-1962.*

Year	NEBRASKA		NEW MEXICO		NORTH DAKOTA		SOUTH DAKOTA
	North Platt	Scotts Bluff	Roswell	Tucumcari	Bismarck	Minot	Pierre
	In.	In.	In.	In.	In.	In.	In.
1920	19.36	18.26	12.58	17.66[d]	11.15	13.76	22.83
1921	11.51	12.62	11.67	23.74	14.05	17.67	19.17
1922	17.26	16.95	6.57	12.37	17.16	20.24	19.47
1923	22.70	20.30	20.04	29.71	15.81	14.44	17.88
1924	13.19	11.52	5.77	13.79	16.67	15.06	17.46
1925	11.28	16.49	11.53	14.43	13.64	10.88	11.84
1926	14.37	14.00	14.79	19.76	12.37	13.42	15.44
1927	19.00	21.19	4.83	13.59	20.84	21.33	19.49
1928	19.79	15.41	15.04	17.59	16.02	12.21[e]	14.09
1929	21.16	17.67	12.38	11.26	14.33	9.66	15.79
1930	24.75	17.26	10.47	12.88	16.76	11.13	15.71
1931	10.01	9.47	14.42	18.09	15.82	12.56	10.96
1932	17.80	14.51	18.83	16.51	14.41	19.20	16.87
1933	17.12	14.64	8.79	16.46	10.86	14.77	16.10
1934	13.56	11.12	6.96	6.13	7.74	7.13	9.26
1935	19.19	18.89	10.54	12.88	17.93	17.83	11.15
1936	11.26	13.12	11.82	13.12	5.97	7.83	9.44
1937	12.37	12.08	13.45	16.70	16.60	14.84	12.85
1938	21.81	19.52	9.08	11.87	13.42	15.22	15.78
1939	11.93	9.86	12.81	12.50	14.49	13.20	13.90
1940	10.98	12.60	14.09	12.71	14.19	16.58	8.85
1941	19.99	15.96	32.92	34.95	20.32	24.90	21.86
1942	29.74	20.68	14.77	14.87	18.04	13.86	20.07
1943	14.34	10.03	8.78	12.05	19.50	20.70	16.35
1944	18.49	13.01	11.35	18.04	19.40	22.69	23.46
1945	20.71	15.01	6.88	14.26	12.73	13.77	14.18
1946	20.74	12.05	11.63	8.42	15.85	11.64	23.37
1947	18.47	18.43	8.26	11.19	18.84	17.51	10.88
1948	15.83	17.47	9.30	16.41	14.90	19.53	17.94
1949	26.09	16.98	14.58	19.93	17.26	15.39	17.10
1950	22.80	11.54	17.02	17.27	15.89	19.81	16.15
1951	33.44	17.96	6.89	8.24	16.62	16.93	23.03
1952	14.36	10.76	8.64	14.29	9.30	13.34	13.09
1953	13.65	12.85	8.24	11.09	19.18	23.37	22.48
1954	10.46	14.70	10.18	14.00	17.62	21.28	16.99
1955	18.10	17.73	8.71	9.66	17.46	11.99	17.64
1956	16.90	10.02	4.35	10.54	16.86	14.38	19.67
1957	29.72	21.91	9.32	12.71	14.14	15.24	18.69
1958	21.77	14.73	13.06	19.51	12.59	12.35	13.18
1959	20.37	14.34	9.52	18.23	12.36	18.21	17.48
1960	15.32	9.40	13.57	29.44	14.04	12.48	19.18
1961	18.71	14.13	7.85	16.12	11.13	10.55	11.00
1962	24.75	17.91	11.81	12.60	14.91	18.11	21.32
TOTAL	785.15	645.08	494.09	667.57	649.17	666.99	709.44
MEAN	18.26	15.00	11.49	15.52	15.10	15.51	16.50

d/ December of 1920 was estimated at monthly mean.

e/ June through October, 1928, estimated at monthly mean.

TABLE XIV. (Cont.) ANNUAL PRECIPITATION: SELECTED STATIONS IN GREAT PLAINS STATES, 1920-1962.*

Year	SOUTH DAKOTA (Cont.)	OKLAHOMA		TEXAS		WYOMING	
	Belle Fourche	Stillwater	Woodward	Abilene	Amarillo	Cheyenne	Sheridan
	In.	In.	In.	In.	In.	In.	In.
1920	21.40	47.44	28.30	35.47	21.82	15.87	15.58
1921	10.37	37.10	29.23	15.61	25.24	13.25	10.31
1922	21.39	34.80	26.44	24.78	19.85	15.38	17.91
1923	27.75	45.39	48.74	32.77	39.75	21.74	29.79
1924	10.11	23.98	30.99	20.23	17.90	16.79	15.91
1925	12.91	22.44	17.57	24.14	23.53	17.14	18.35
1926	14.67	32.73	31.77	31.50	26.25	17.60	15.12
1927	23.16	38.10	24.73	19.40	15.42	20.06	21.78
1928	15.10	32.52	32.96	29.68	32.34	14.67	17.04
1929	19.35	38.45	26.48	19.11	18.87	18.42	17.55
1930	12.23	26.05	23.31	26.86	17.58	20.64	9.23
1931	7.77	30.90	29.86	28.26	18.35	12.79	14.53
1932	15.31	39.08	28.73	46.43	21.14	11.26	19.53
1933	12.94	35.75	17.10	17.72	12.22	16.88	12.18
1934	8.46	30.67	23.61	13.41	13.33	11.44	11.56
1935	10.72	33.59	20.91	29.42	15.49	17.69	12.09
1936	8.96	18.29	18.11	22.85	19.72	14.19	11.14
1937	16.31	25.49	19.77	19.86	17.10	14.48	15.23
1938	11.90	35.29	30.28	32.18	19.10	17.47	16.98
1939	9.35	26.95	20.35	21.36	21.01	9.84	16.40
1940	13.14	33.93	22.68	19.87	13.62	15.02	13.69
1941	23.09	43.68	45.77	42.42	37.21	18.96	15.18
1942	17.01	45.33	26.38	27.66	21.62	23.69	16.51
1943	11.98	31.07	21.10	13.75	18.38	13.95	17.85
1944	17.44	31.24	33.49	24.29	23.60	15.57	24.58
1945	13.11	34.03	22.20	22.88	17.19	16.51	18.69
1946	25.41	28.30	27.17	15.48	20.80	18.18	23.57
1947	13.66	27.40	20.76 f/	20.02	15.48	16.97	18.87
1948	14.83	31.64	26.13	13.94	24.38	11.91	20.14
1949	11.46	30.24	28.02	28.37	25.15	20.50	15.97
1950	11.31	22.80	30.87	26.30	23.18	14.40	14.53
1951	14.57	34.67	23.66	14.83	25.29	17.16	14.79
1952	8.91	24.12	15.37	13.88	12.15	12.60	14.90
1953	15.36	32.71	17.97	19.75	13.05	15.24	14.35
1954	8.92	18.33	13.00	16.02	13.89	10.34	13.17
1955	12.47	27.98	17.07	22.68	13.71	15.46	23.82
1956	10.09	16.68	16.40	9.78	9.94	11.40	15.42
1957	16.38	48.59	41.73	36.57	21.24	19.84	19.17
1958	12.76	31.85	26.56	27.49	23.29	16.57	14.43
1959	9.50	61.87	28.22	27.31	22.81	13.07	10.32
1960	9.91	35.99	28.17	25.09	36.67	8.22	8.23
1961	10.28	38.89	26.23	35.55	22.44	16.99	14.67
1962	20.38	32.43	20.06	27.12	29.76	14.62	13.78
TOTAL	612.13	1418.78	1108.25	1042.09	900.86	674.77	694.84
MEAN	14.24	32.99	25.77	24.23	20.95	15.69	16.16

* Source: U. S. Department of Commerce, Weather Bureau, Various Annual Summaries, 1920-1962.

f/ April, 1947, estimated a mean of 1931-1952.

TABLE XV. ANNUAL PRECIPITATION CORRELATION COEFFICIENTS: BETWEEN SELECTED MONTANA AND GREAT PLAINS STATIONS, 1920 TO 1962.

	Cut Bank	Conrad	Gt. Falls	Geraldine	Moccasin	Havre	Billings	Miles City	Poplar	Glendive	Bismarck	Minot	Pierre	Belle Fourche	Cheyenne	Sheridan	North Platte	Scotts Bluff	Port Morgan	Lamar	Garden City	Hays	Stillwater	Woodward	Roswell	Tucumcari	Abilene	Amarillo
Cut Bank																												
Conrad	.558																											
Gt. Falls	.539	.560																										
Geraldine	.213	.403	.751																									
Moccasin	.079	.225	.540	.649																								
Havre	.432	.540	.726	.583	.404																							
Billings	.083	.228	.426	.410	.269	.428																						
Miles City	.240	.367	.607	.624	.727	.395	.384																					
Poplar	.233	.242	.440	.493	.574	.376	.211	.654																				
Glendive	.173	.222	.413	.443	.668	.392	.365	.710	.666																			
Bismarck	.192	.374	.341	.307	.289	.230	.325	.536	.502	.510																		
Minot	.058	.328	.429	.599	.467	.290	.311	.609	.585	.487	.663																	
Pierre	.143	.196	.509	.593	.611	.281	.224	.623	.461	.339	.457	.498																
Belle Fourche	.252	.317	.472	.354	.649	.355	.283	.741	.370	.557	.352	.266	.557															
Cheyenne	.199	.278	.254	.053	.363	.258	.362	.346	.004	.431	.275	-.030	.168	.527														
Sheridan	.276	.268	.453	.204	.452	.322	.349	.522	.314	.438	.359	.147	.274	.618	.351													
North Platte	.140	.095	.339	.309	.361	.129	.383	.325	.007	.265	.201	.041	.432	.382	.617	.192												
Scotts Bluff	.204	.203	.410	.349	.449	.414	.452	.397	.129	.450	.220	.115	.218	.513	.699	.357	.641											
Port Morgan	.270	.067	.162	.105	.322	.059	.217	.344	.170	.381	.156	-.023	.235	.396	.659	.235	.535	.555										
Lamar	.300	.302	.348	.265	.475	.261	.310	.510	.207	.367	.274	.098	.474	.556	.633	.389	.555	.397	.509									
Garden City	.141	.212	.396	.303	.417	.165	.165	.451	.078	.202	.197	.065	.423	.487	.418	.346	.535	.260	.354	.739								
Hays	.273	.260	.495	.425	.305	.254	.342	.447	.007	.281	.266	.158	.270	.381	.398	.272	.646	.478	.316	.530	.618							
Stillwater	-.052	.128	.268	.433	.425	.267	.246	.284	.015	.167	-.015	.174	.301	.386	.317	.076	.427	.441	.234	.320	.295	.429						
Woodward	-.013	.164	.270	.194	.323	.155	.233	.284	-.099	.151	.147	.151	.281	.479	.387	.341	.361	.269	.075	.588	.610	.437	.564					
Roswell	-.203	.114	.098	.093	.233	.065	.199	.209	-.022	.099	.129	.173	.076	.332	.151	.061	.069	.022	-.038	.316	.425	.297	.245	.585				
Tucumcari	-.206	.006	.036	.109	.167	.069	.038	.117	-.085	-.039	.083	.227	.169	.212	.053	-.025	-.029	-.028	-.017	.337	.393	.130	.357	.626	.729			
Abilene	-.194	-.115	.100	.100	.240	.129	.448	.076	-.103	.172	-.005	.074	.042	.265	.309	.096	.310	.370	.146	.272	.291	.408	.511	.611	.609	.485		
Amarillo	-.065	.032	.185	.222	.307	.105	.040	.270	-.037	.019	.073	.077	.304	.403	.144	.140	.297	.167	.036	.503	.580	.436	.386	.710	.650	.748	.501	

are much closer to the Rocky Mountains than Billings and Miles City) are over .500. This may also explain why, in 1962 and 1963, the crop-losses from drouth in the northwestern part of the state were so high, when in the same years, the losses were extremely low in the northeastern counties.

Generally over the Great Plains, the correlation coefficients tend to decrease as distance between the two stations increases, indicating an increase in randomness. However, there are some patterns worthy of attention: Cut Bank has a significant correlation with none of the other selected stations outside of Montana, and Conrad with only three. This is another indication that Cut Bank weather in particular is dominated by a weather pattern different than for the rest of the Great Plains, or is influenced less by the Canadian and Atlantic storm patterns.

Bismarck, Pierre and Minot precipitation correlates significantly with few stations outside of Montana and the Dakotas, there being only three out of 42 pairs where the coefficient is over .302. On the other hand, the same three stations correlate significantly in 29 out of 39 pairs in Montana and the Dakotas. Further evidence of a North-South cleavage in the weather pattern is that Oklahoma, Texas and New Mexico stations correlate significantly with only 31 out of the 132 pairings with stations outside the area, or about one-fourth. This compares with 14 out of 15 within the area.

Although there are some negative correlations, none are significant at the 95 percent level. Most of them are between Cut Bank and Poplar and the extreme southern stations. Generally this means that there is no significant evidence of inverse precipitation patterns between stations in the Plains.

The conclusion from the above evidence is that the drouth peril does not occur randomly over the Great Plains on an annual basis. However, the larger the area the greater the degree of randomness. There are also indications of frequent local random drouth occurrences.

Randomness Over Time.--If drouths do not occur randomly geographically on an annual basis, then the actuarial period must be extended. The

problem becomes that of determining how long a period is necessary in order to establish premiums that will pay the indemnities as required by law. The period is not specified by law, but left to the discretion of the management:

> Sec. 508. To carry out the purposes of this title the Corporation is authorized and empowered--
>
> (b) To fix adequate premiums for insurance in the agricultural commodity or in cash, at such rates as the Board deems sufficient to cover claims for crop losses on such insurance and to establish as expeditiously as possible a reasonable reserve against unforeseen losses: . . . 17/

If it were possible to establish precipitation cycles that had narrow limits of variation, it would be a simple matter to select an actuarial period. However, even if the time could be established, there would still be the matter of the relative severity of the drouth periods. Tannehill reasoned that there were cycles related to sunspot cycles, but he had little faith in their regularity:

> There is good reason to look for a national dry year about once every five or six years. When rainfall tends to be generally deficient, we have two or more dry years in one spell; and when rainfall is generally heavy, the drought is less serious. . . . The average interval is 5.65 years, which is very close to one half the sunspot period; but there is much irregularity.
>
> Because of lack of data from the oceans and the polar regions, the explanation cannot be fully established. . . . Because of the several variable factors, including variations in the solar cycle, the seasonal effects, and the lag of ocean temperatures, we can hardly expect great regularity. The complications are obvious when we realize that the rise of solar radiation in a new cycle, short or long, may begin while the sun is south of the equator, north of the equator or crossing the equator in either direction, and that each of these events would bring a slightly different sequence of conditions in the ensuing years. Add to this the variability in the length of the sunspot period and the probable variations in actual intensity of solar radiation, and we have a difficult problem. But the main features of the rainfall variations are beginning to emerge.

17/ USDA, FCIC, Federal Crop Insurance Act, As Amended Through August 4, 1959, Washington, D. C. pp. 5-6.

> The complete solution of this problem will have to wait until more data are accumulated. In the meantime, we can watch the rise and fall of our national rainfall from year to year and feel confident that it certainly is not just a random combination of rainless or rainy days. We may hope for a better understanding in the future. 18/

The studies of tree-ring growths in the 1930's and 1940's was a breakthrough in extending knowledge of precipitation back beyond weather records. They are not accurate indicators of precipitation because they neither indicated the timeliness nor the carry-over of moisture. 19/ However, they do establish the recurrence of wet and dry periods, and groups of drouth years. They also furnish further proof of extreme irregularity in the occurrence of the wet and dry periods, as well as in the intensity. Table XVI is a reproduction of the tree-ring-growth study by George F. Will in North Dakota. The point that is learned from a study such as this is that the probability of crop loss from drouth would be considerably different depending upon (1) the period chosen for a historical base and (2) how long a projection period is used for actuarial prediction. Assume for instance that a crop insurance program had begun in 1922, using the previous 20 or so years upon which to base probable losses over the next 20 years. According to the table, the historical base included approximately 17 average-to-wet years and 3 dry years. The insurance program, however, would have been moving into a period of 15 dry years and only 3-5 wet or average years.

Another approach is used here to demonstrate the importance of considering the time element with respect to randomness of occurrence of drouth: Annual precipitation of 20 Great Plains stations (Havre and Great Falls, Montana, plus two from each of the other nine states) from 1920 to 1962 was analyzed to determine how many of the stations were below their 43-year means each year (See Figure 13). It should not be concluded from this

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18/ Tannehill, op. cit., pp. 161-164.

19/ Kraenzel, op. cit., page 18.

TABLE XVI. WET AND DRY PERIODS, BY DURATION IN YEARS, BASED ON A STUDY OF TREE RINGS FOR A MASTER BURR-OAK STUMP AND RELATED DATA, FOUND NEAR BISMARCK, NORTH DAKOTA, BY GEORGE F. WILL, COVERING THE PERIOD 1406-1940. *

Dry Years		Wet Years	Dry Years		Wet Years
(9)	1406-15			1649-54	(5)
	1415-33	(18)	(9)	1654-63	
(2)	1434-35			1663-1702	(39)
	1435-37	(2)	(1)	1703	
(15)	1437-52			1703-06	(3)
	1452-71	(19)	(13)	1707-20	
(14)	1471-85			1720-23	(3)
	1485-88	(3)	(7)	1728-35	
(13)	1488-1501			1735-38	(3)
	1501-05	(4)	(2)	1738-40	
(13)	1505-18			1740-44	(4)
	1518-25	(7)	(8)	1744-52	
(6)	1525-31		(9)	1752-86	(10)
	1531-39	(8)		1786-1802	(16)
(4)	1539-43		(7)	1802-1830	(7)
	1543-47	(4)		1830-36	(6)
(6)	1547-53		(15)	1836-51	
	1553-62	(9)		1851-63	(12)
(14)	1562-76			1865-67	(2)
	1576-96	(20)		1870-76	(6)
(15)	1596-1611		(14)	1877-91	
	1611-23	(12)		1891-93	(2)
(2)	1623-25		(6)	1894-1900	
	1626	(1)		1900-02	(2)
(1)	1627		(3)	1902-05	
	1627-31	(4)		1910-20	(10)
(16)	1633-49		(15)	1922-37	
				1937-40	(3)

* Source: Kraenzel, C. F., The Great Plains in Transition, U. of Oklahoma Press, Norman, 1955, page 19.

"Tree Ring Study in North Dakota," Agricultural Experiment Station, North Dakota Agricultural College, Bulletin No. 338. (April, 1946), pp. 21-22. The years not shown (1631-33, 1723-28, 1863-65, 1867-70, 1876-77, 1893-94, 1905-10, and 1920-22) were average years.

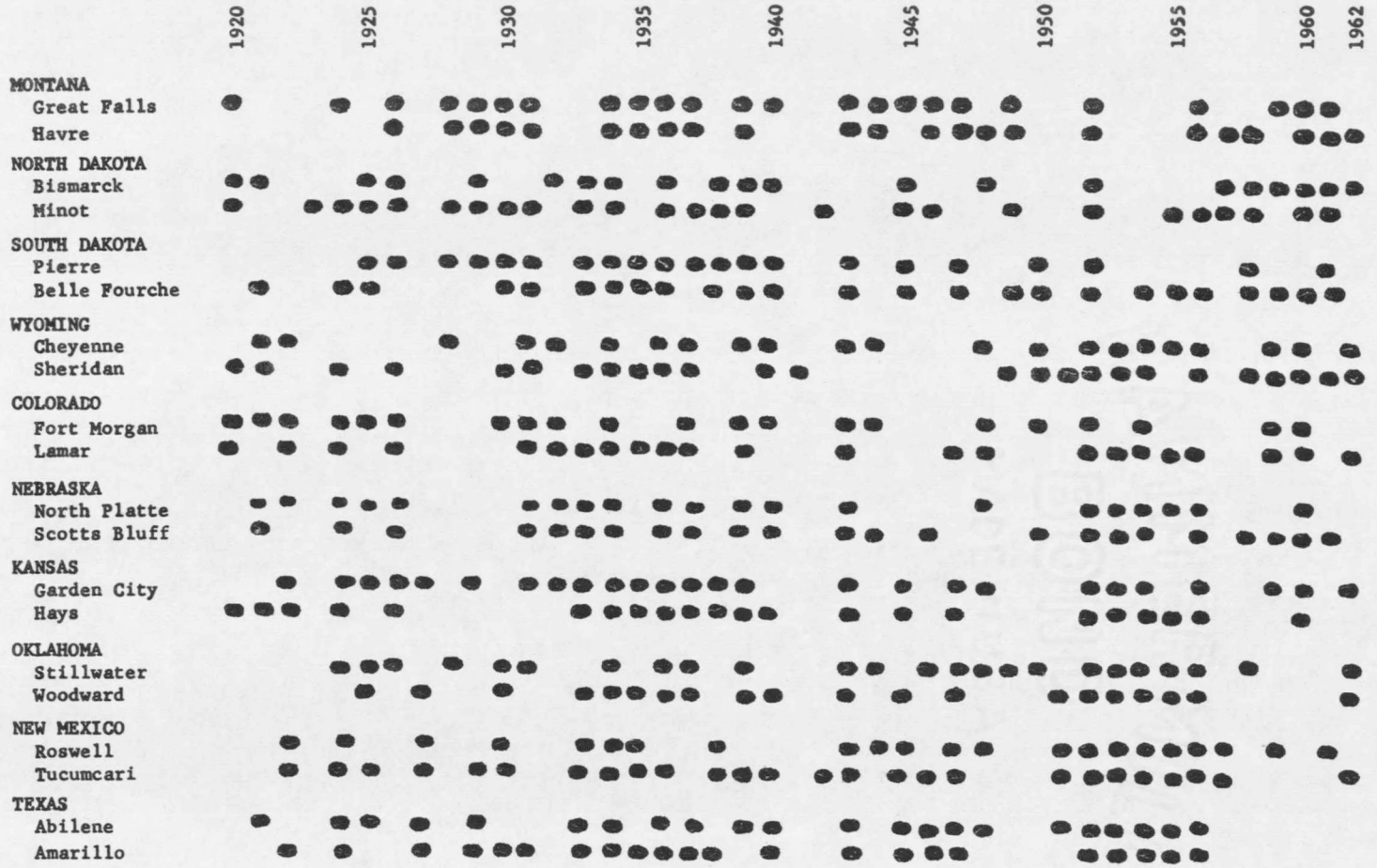

Figure 13. Selected Great Plains Weather Stations: Years When Annual Precipitation Was Less Than the 1920-1962 Mean of the Annual Precipitation for Each Station.

chart that each below-average year was a drouth year. Crops depend upon timeliness and carry-over of moisture. However, the "bunchiness" of the below-average years, and the proportion of the stations that were below average each year should add to the general knowledge of what to expect in the future:

All 20 stations were below their 43-year means in 1934 and 1952
18 " " " " " " " 1936
17 " " " " " " " 1939, 1943, and 1956
16 " " " " " " " 1937
15 " " " " " " " 1924 and 1954
14 " " " " " " " 1931, 1933, and 1940
13 " " " " " " " 1926, 1947, 1953, and 1960
12 " " " " " " " 1930, 1935, 1945, and 1955
11 " " " " " " " 1925

Less than 11 stations were below their respective means the other 22 of the 43 years.

In 9 of the 43 years at least 15 stations were below their 43-year means, and in 4 years of the 1930's at least 16 stations were below their means.

The bunching of below-average years is also apparent in Figure 13. Generally, the chart indicates more grouping of dry years for all stations in the 1930's and for the southern stations in the 1950's. Particularly noticeable are stations like Pierre, Lamar, Garden City, and Hays in the 1930's which all had seven or more consecutive dry years. Likewise, Roswell and Tucumcari each had seven dry years in a row in the 1950's. It should be noted that the bunching of dry years is more critical with some stations than with others. For example, the 43-year mean for Great Falls is two inches greater than the mean for Havre, though the two stations are less than 100 miles apart. The grouping of below-average years for Havre would thus tend to be more critical than for Great Falls.

It was noted at the beginning of this chapter that the long-time average precipitation in the Great Plains is at or near the critical level for crop production. Therefore it is expected that years in which the total rainfall is less than 80 percent of the 43-year mean are definitely

critical from the standpoint of crop production. Loss experience for insured crops would tend to be high in such years. Figure 14 shows that:

16	stations	were	below	80	percent	of	their	means	in 1934
15	"	"	"	"	"	"	"	"	" 1952
13	"	"	"	"	"	"	"	"	" 1936
12	"	"	"	"	"	"	"	"	" 1956
11	"	"	"	"	"	"	"	"	" 1939
9	"	"	"	"	"	"	"	"	" 1937
8	"	"	"	"	"	"	"	"	" 1931, 1935, 1943, and 1954
7	"	"	"	"	"	"	"	"	" 1924, 1933, and 1960

Here again 1934 and 1952 appear as the most general dry years, and at least 11 of the stations showed an annual rainfall less than 80 percent of their 43-year means in three years of the 1930's. Again, the bunching of critical years appears in the 1930's for all stations, and in the 1950's for the southern Plains.

Most significant from the standpoint of randomness over time is the contribution of these weather data to an understanding of how long an actuarial period should be considered in setting premiums and comparing losses. Both Figure 13 and 14 show that if the crop insurance program had been begun in 1920, it would have experienced two rather similar 20-year periods from the standpoint of rainfall in the Great Plains. The first ten years tended to be above average, followed by ten years of drouth and grouped dry years. The 1940's were relatively free of critical years, followed again by the drouths, particularly in the southern plains, of the 1950's. To the extent that precipitation is correlated with amount of crop losses, it can be concluded that, to achieve the effect of randomness of drouth occurrence over time, an actuarial period of at least 20 years is necessary. 20/

20/ It should be noted here that "randomness" itself is not achieved by the extension of time since the wet and dry years may or may not be independent of each other. Some writers argue that they are not. The main point is that if an insurance plan were to have achieved the effect of randomness in the past 40 years, the shortest actuarial period would have had to be at least 20 years long.

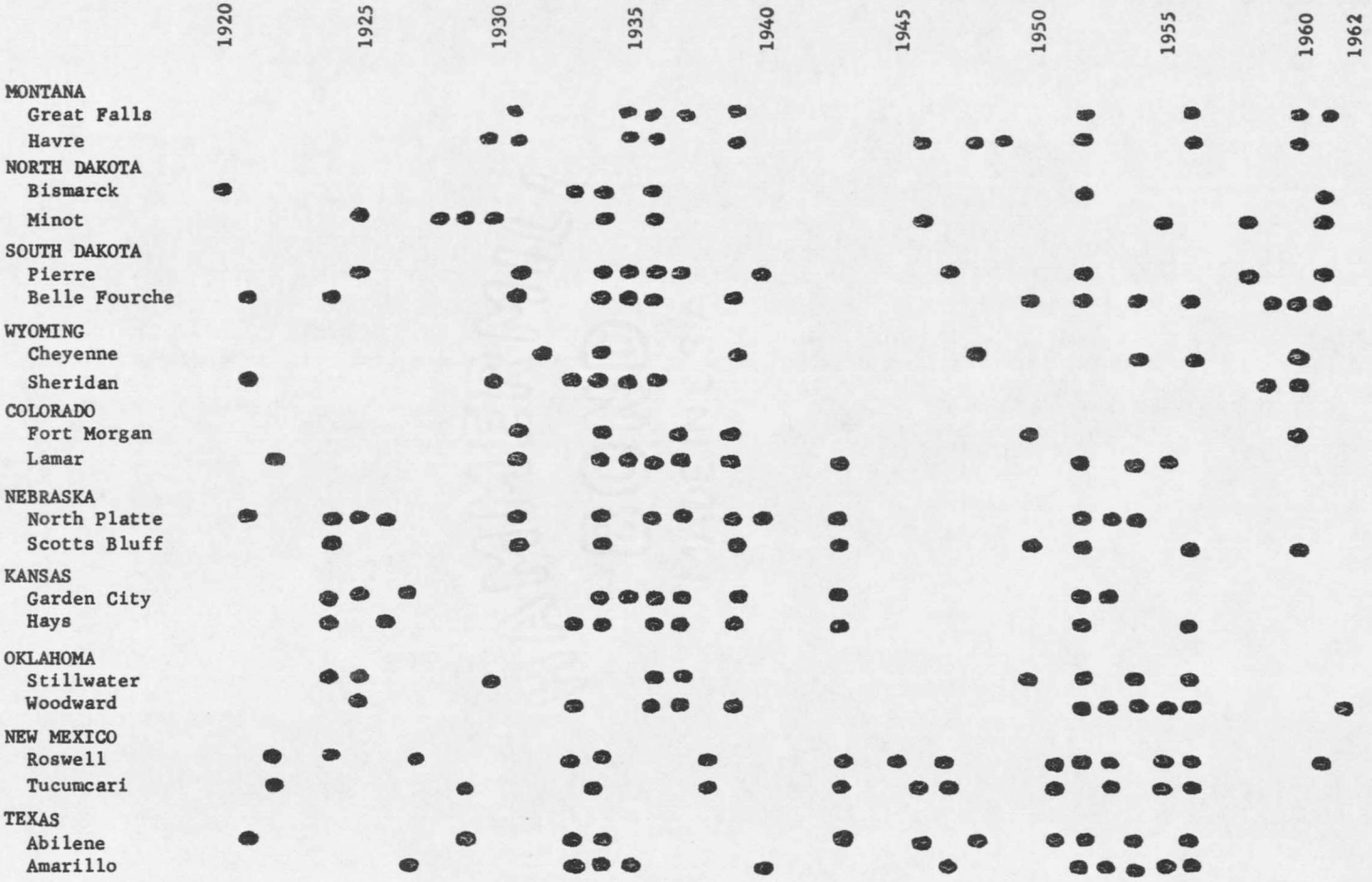

Figure 14. Selected Great Plains Weather Stations: Years When Annual Precipitation Was Less Than 80% of the 1920-1962 Mean of the Annual Precipitation for Each Station.

"Bunchiness" of wet and dry years has been mentioned several times above. It is an indication of non-randomness over time, because if there is a real tendency for years to bunch it can also be said that there is some tendency for dry years to follow dry, and wet years to follow wet. The bunching of dry years was of concern to the early proponents of crop insurance when they argued that whereas farmers could survive one, or even two consecutive years of drouth, they could not maintain solvency with more. Schickele was aware of the problem when he wrote in 1949:

> Fundamentally, with respect to the time dimension relevant to planning and decision-making by individuals and groups, the weather factor in this region represents an uncertainty of a kind that seems to preclude actuarial determination or annual budgetable costs of weather risks. This may mean that a "sound" crop insurance program with premiums balancing indemnities over a reasonable time span (which could hardly exceed 15 years or so) might prove impossible; that the utmost thrift of individuals during good years would yield reserves insufficient to tide the farm business and family over long years of crop failure; that the nation might have to come to the rescue of Great Plains agriculture once or twice during a generation; and that if we fail to adapt our economic institutions to the weather uncertainty, we might fail to preserve dry-land farming in the Plains--or preserve it at a staggering social and human cost.
>
> The yield variability itself, high as it is, does not constitute the core of the economic problem. It is the bunching of poor and good years into long periods and their universal incidence that taxes the farm economy of the Plains. 21/

Evidence of bunchiness of wet and dry years was noted in tree-ring growth studies. It is noted again in the 43-year rainfall records from selected Great Plains weather stations.

Some attempts have been made to test statistically for bunchiness in time series with varying degrees of success. Two tests, the Wallis-Moore and the Wald-Wulfowitz, have been discussed by Lin, Hildreth and Tefertiller and applied to cotton and grain sorghum yield data in Texas, resulting in two important conclusions:

21/ Schickele, Rainer, "Farm Business Survival Under Extreme Weather Risks," Journal of Farm Economics, November, 1949, Part 2, pp. 931-932.

> The results of this work show the merit of using more than one test for randomness. The results also show the danger of using the Wallis-Moore test when the definition of a run is arbitrarily selected. 22/

They also pointed out that the Wald-Wulfowitz, being a circular test, is limited in its usefulness to time series without a strong trend. This limit in itself would make the test useless with respect to Plains wheat-yield data, where, because of too many random variables, it is impossible to prove the existence or non-existence of a trend over the years.

To demonstrate the use of the Wald-Wulfowitz test, it was applied to the 1919 to 1961 yield series of Montana State-lease tracts in Wibaux County. In the process, the test was found to be unwieldy, building up 11-digit numbers, using only 3-digit numbers in the raw data. The result was an observed t value that was not significant at the five percent level, whereby the null hypothesis of randomness could not be rejected.

The same data was submitted to the Wallis-Moore test, arbitrarily using turning points in yields as "runs". A X^2 of 18.62 was obtained, which is significant at the one percent level. However, 14.67 of the value was due to one run of 5 years duration. Then a different definition of run was taken, using groups above and below the mean. This definition resulted in a X^2 of 43,477, completely dominated by one run of 10 years!

The 43-year record of annual rainfall at Havre, Montana was tested by both methods. First, runs defined by consecutive years above or below the 43-year mean were tested by the Wallis-Moore formula. The X^2 of 25.50 is significant at the one percent level. When the runs were defined as consecutive years either increasing or decreasing, X^2 was 11.97, also significant at the one percent level. Under both definitions of runs, the data was significantly "bunchy" or non-random. The Wald-Wulfowitz test, when applied to the same data, produced an observed t of .436 which is not

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22/ Ying-Shiang Lin, Hildreth, R. J., Tefertiller, K. R., "Non-Parametric Tests for Bunchiness of Dryland Crop Yields and Reinvestment Income," Journal of Farm Economics, August, 1963, page 598.

significant at the one-percent, or even five-percent level, indicating randomness of the series.

Table XVII is a tabulation of results obtained by Tefertiller et. al. in testing cotton and grain sorghum yields. The inconsistency of the two tests is again demonstrated: The results of the Wallis-Moore test applied to cotton-yield data were significant under all definitions of runs of years, but the result of the Wald-Wulfowitz test was not significant, even at the five-percent level. The grain sorghum yield data produced a significant X^2 under only one definition of runs, and a significant t value under the Wald-Wulfowitz test. Two definitions of runs resulted in significant X^2 on the reinvestment income and also a significant t value. 23/

Whereas the above demonstrations did little to inspire the author's confidence in the use of the two tests, he is aware of a predominance of evidence toward bunchiness and non-randomness in yield and weather data thus far examined and tested. Bostwick contributed further evidence, based on the Wallis-Moore test, from which he concludes:

> The data we have tested for Oklahoma, South Dakota, and Montana support a hypothesis of bunchy yields. This finding compromises the use of traditional probability analyses, which assume randomly distributed sequential observations. 24/

Hail

Early in this chapter it was noted that the occurrence of hail in Montana is extremely varied over the state, but that it also tends to follow geographic patterns, as evidenced by the hail-rate pattern. This phenomena provides the evidence that the hail peril does not occur randomly geographically over the state. The hail-rate map indicates that to obtain randomness geographically would require an area larger than a state, in the

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23/ Ibid., page 596.

24/ Bostwick, Don, "Yield Probabilities as a Markov Process," Agricultural Economics Research, USDA, Vol. XLV, No. 2, April, 1962, page 50.

TABLE XVII. RESULTS OF TWO NON-PARAMETRIC TESTS FOR COTTON AND GRAIN SORGHUM YIELDS AND REINVESTMENT INCOME TIME SERIES, BIG SPRING, TEXAS 1916-55. *

	Cotton Yield	Grain Sorghum Yield	Reinvestment Income
X_P^2 (Wallis-Moore)			
Definition of runs of years:			
Change of direction of original data	7.40 a/	5.02	1.68
Standard deviation of 0.3	7.94 b/	1.82	1.18
Standard deviation of 0.5	11.46 b/	2.28	5.38
Standard deviation of 0.8	11.22 b/	3.79	8.28 a/
Change in direction of four-year moving average	8.06 a/	9.87 a/	6.12 a/
t (Wald-Wulfowitz)	1.49	1.91 a/	1.89 a/

* Source: Ying-Shiang Lin, Hildreth, R. J., and Tefertiller, K. R., "Non-parametric Statistical Tests for Bunchiness of Dryland Crop Yields and Reinvestment Income," Journal of Farm Economics, August, 1963, page 596.

a/ Significant at the 5 percent level.

b/ Significant at the 1 percent level.

Great Plains. Private hail-insurance companies often limit their coverage to certain per-acre values to avoid the effects of non-randomness of loss in one year. They also exchange policies and reinsure with other companies to spread their losses over greater territory.

Little evidence could be found to indicate whether or not the occurrence of hail was random over time, or whether years of high hail losses tended to be bunchy. It was pointed out earlier in this chapter that wet years would tend to provide more favorable conditions for hail, and therefore the tendency would be to have more hail in wet years. When the relative loss from hail would tend to be less critical than when the crop is short.

The conclusion is that the randomness of occurrence of hail is not as critical as drouth, that there is some chance that increased hail is not

as critical as drouth, that there is some chance that increased hail incidence is concurrent to some extent (whether a causal relationship exists or not) with less drouth peril.

Summary--Randomness of Perils

Evidence tends to substantiate non-randomness of occurrence of drouth over the Great Plains in short time periods such as a year, and to a lesser extent over longer periods of time. The randomness is increased as the area is increased. There were, however, two periods in the past forty years when relatively severe drouth covered the entire Plains--1934 to 1936, and 1952. On a state basis, the northern part of the Plains experienced most severe periods of drouth in the 1930's, while the southern part experienced them in the 1950's. Generally, the pattern (distribution) of drouth years at selected stations in the Great Plains indicates that an actuarial period of at least 20 years is required to achieve the effect of randomness over time. If a wheat crop insurance program had been begun in 1920, it would have passed through about ten years of relatively high rainfall, followed by ten years of relatively low, with the "cycle" repeated in the following twenty years.

This leads one to believe that premiums should be promulgated on the basis of at least 20 years history, projected for 20 years ahead. Likewise, loss experience and reserve fluctuations must be considered over periods of at least 20 years. This means that the loss experience for any given year is not an indicator of the success of the program. Neither is the cumulative loss experience, unless it is related to the actuarial period and to predictions within that period. For example, if an actuarial period had been set up for 20 years beginning in 1947 for wheat crop insurance, it would be expected that by the year 1967 the cumulative loss ratio for the 20-year period should be near to 1.0. If it were appreciably different from 1.0, the cause of error should be determined. Causes of error might be changes in technology, "super abnormal" periods of either good or bad climatic conditions, new types of perils, or "super-abnormal"

conditions in the historical base. Appropriate corrections could then be made for the next projection of rates over a new actuarial period.

An important point to be considered here is the tendency to evaluate the loss experience of individuals, counties, and even states on the basis of a relatively short period (much less than 20 years--sometimes even as short as one year). For example, because of the nature of weather, as discussed above, it is possible for a county or rate area to experience the occurrence of a random severe drouth, resulting in a loss-ratio from which it could take 10 or 15 years of low-loss years to recover. The problem then in judging loss ratios is to determine as nearly as possible whether a good or bad loss ratio for a given short period is the result of an unusual random factor, or whether it is contemplated in the long-term actuarial data on loss experiences. It would be a mistake to adjust on the basis of these short-term random occurrences, whether for a county, area or individual.

The non-randomness of occurrence of hail does not appear to be critical over large areas (especially such as the Great Plains), but is likely to be critical over local rate areas. For the reason that it is relatively a much less important cause of loss than drouth, and that there is reason to expect it to be most prevalent in wet years, the non-randomness of hail occurrence is less critical particularly in all-risk crop insurance. Its characteristics are more important in merit rating, considered in the next chapter.

The other perils generally are too insignificant, individually, to be of much concern with respect to randomness. Until one of them appears as a major cause of loss, it might be postulated that there are enough of these perils (such as insects, disease, wind, water, and winterkill) that they collectively result in randomness.

Homogeneity of Insureds--Selectivity--Critical Level

The first requisite for ideal insurability, listed in Chapter II, includes homogeneity among the insured, a requirement for measurability of risk. With all types of insurance, this requirement is impossible

of perfect attainment. If homogeneity is unattainable, the problem then becomes that of whether the insureds are normally distributed with respect to their different characteristics. Also it becomes important to analyze the differences between insureds within a rating group, and determine which differences are random, wherein there may be biases one direction or another, and which of the differences are the result of voluntary acts of the insureds. The latter differences would include such factors as management and loss-prevention activities.

The principal method of attaining a maximum degree of homogeneity is to group or stratify the population for which the insurance is intended, or for which a rate is being calculated. In fire insurance, risks are stratified according to area and according to construction of property within the areas. In health and accident insurance, the population is stratified according to age and occupation. In the Federal crop insurance program the only stratification that is applied is on the basis of soil and other production-factor differences. Arbitrary grouping of insureds according to county and state lines can hardly be considered related to obtaining homogeneity of insureds, except as such lines occur on natural topographic divisions, or other well-defined production-affecting lines.

Grouping of risks by area in the crop insurance program does create a higher degree of homogeneity than there would be without it. The differences that remain between insureds should be analyzed individually as they affect crop-loss indemnities. This is the point at which the "critical level" again becomes important. Also there is concern with bias or adverse selectivity. This results in the loss expectancy of the insured group being higher than that of the total population upon which the rates are based.

Size Differences

Size differences between insureds will be discussed in detail in Chapter VII, under merit rating. However, size has been one of the most important factors affecting homogeneity of insureds, and will become more and more important as farms continue to grow in size. In some areas, such

as Big Horn County, Montana, where the number of farms is relatively small, and where the average farm size is large compared with the rest of the state, categorizing by size results in very few farms in each size category. Further, one farm, such as the Campbell Farms, Inc., stands apart from any population distribution that makes statistical sense. A similar situation exists in areas like northern Toole County, Montana. Some idea of the type of size distribution among cash grain farmers in the Great Plains is given by a typical random selection of farmers in two areas of Montana. Table XVIII shows the number of farms in various size categories in two cash grain areas, the Triangle of north central Montana, and the Northeast. There is little evidence of a "bell-shaped" distribution according to size; the number in the "over 2,000" class indicates a wide skew to the large size, particularly in the Triangle.

The point here is that whatever are the size affects on risk of loss in the Great Plains, the effects cannot be treated as a random distribution in the premium-making formulas. This is why size effects are treated in more detail in the next chapter on merit rating.

Management Differences

Because of the typical extreme variations in climate and soils in the Great Plains, it is difficult to isolate scientifically the results of management differences between individual farmers in the area. On the other hand, those familiar with the cash grain areas, such as this author, have noted consistent differences, especially in years of poor crops. The differences are evident in such things as timeliness in operations, weed control (both in crops and on summerfallow), control of soil blowing and washing, experimentation and use of new technologies, care of seed and use of new and better varieties, and attention to insects and disease. Observations indicate that the outstandingly successful farmers are out in front experimenting with fertilizer on dryland grain, as well as continually experimenting with tillage methods, rarely using the same methods for all their operations. Most of this experimentation is aimed not only at increasing yields, but cutting down the risks from blowing, water

TABLE XVIII. NUMBER OF FARMERS BY SIZE (CROPLAND), AREA, AND TENURE, SELECTED MONTANA FARMS. *

Acres of Cropland	Triangle				Northeast			
	Full Owner	Part Owner	Full Tenant	All Farmers	Full Owner	Part Owner	Full Tenant	All Farmers
	No.	No.	No.	No.	No.	No.	No.	No.
0 - 599	5	6	1	12	10	12	3	25
600 - 999	4	11	7	22	8	18	5	31
1,000 - 1,499	2	14	4	20	4	11	2	17
1,500 - 1,999	3	16	1	20	--	12	2	14
2,000 and over	4	19	2	25	1	7	3	11
Total	18	66	15	99	23	60	15	98

* Source: Rodewald, Gordon E. Jr., D. K. Larson, and D. C. Myrick, Dryland Grain Farms in Montana, Mont. Agr. Exp. Station, Montana State College, Bozeman, Montana in cooperation with Farm Production Economics Div., ERS, USDA, Bulletin 579, July 1963.

erosion, winterkill, drouth, weeds, insects and disease. On the other hand, experimentation is carried on with caution, so as to avoid increasing crop-loss risk.

Again, it should be emphasized that the "critical level" of yield is an important consideration. In years of normal or better rainfall and other crop conditions, management differences are not as apparent as in years when crop conditions are below normal, where average yields are near the insurance-coverage levels. For instance, perfectly clean summerfallow before a year of ample rainfall would not spell the difference whether an indemnity would be paid. However, the same good management before a year of critical rainfall may very well determine whether and how much indemnity would be paid. Timeliness of summerfallowing itself can make a big difference in how much fall and spring moisture is conserved in the soil in a year of critical rainfall.

In summary, it is a mistake to conclude that management is not a critical factor in cash-grain production. In favorable crop years the effect of management differences may not be obvious, but the effect of

these same differences may be very pronounced when average yields are near the critical insurance-coverage level. Consequently, a lack of homogeneity among insureds due to management dirrences can be expected.

CHAPTER VII

MERIT RATING

The General Theory

Merit rating is a method of solving insurance problems created by the deviations from ideal requirements for insurability, listed in Chapter II. Perfect randomness of perils, perfect homogeneity of insureds, perfect grouping of risks, and perfect rate determination are goals that are not attainable in any insurance program. Human activities are functions of many variables, and consequently it is impossible to devise any kind of grouping that will assure a homogeneous population as far as risk is concerned, whether it be for purposes of life insurance, fire insurance, casualty insurance or crop insurance. Michelbacker describes the situation:

> Manual-classification systems divide risks into broad groups on the basis of certain selected characteristics following which the manual rate is assigned to all the risks within each group. This process would suffice if each risk within a particular group were exactly the same as every other risk of the same class, for under these conditions, the application of the average rate determined from the collective experience would be fair. 1/

Since merit rating is designed principally to handle the effect of differences between individual risks, the first hypothesis is that merit rating can be used to better advantage than as presently used in solving the problems of crop insurance which arise out of these differences. Many varieties of merit rating are available, but few have been fully exploited in the Federal crop insurance program as a substitute, for instance, for area delineation within counties or in lieu of a broader interpretation of an insurance unit.

The size of rate reductions can be as important as the type of rating plan used, and should be closely related to equitability as well as to other purposes which are to be accomplished. The second hypothesis then

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1/ Michelbacker, G. F., et. al., Casualty Insurance Principles, McGraw-Hill, New York, 1942 (Chapters VII and VIII are by F. S. Perryman, Actuary) page 231.

is that rate reductions for individual risk differences can be used to accomplish certain purposes only if closely related to these purposes. The size of the reductions should be carefully controlled, not only with regard to accomplishing certain purposes, but also with regard to the difficulty of making adjustments. This latter regard is important because reductions are much more easily increased than decreased.

Some type of merit rating is used in all types of insurance in some way and to some degree. Life insurance risks are classified according to whether they are preferred, standard or substandard, and extra premium charges are made accordingly. In dwelling fire insurance, rates are varied as to fire protection availability and as to whether the building is constructed of solid masonry or wood. In commercial fire insurance individual buildings are assigned special rates which depend upon construction, fire protection, adjacent property, use, and other factors which affect fire risk. In automobile insurance, not only are risks classified according to principal drivers and uses, but some companies allow experience rate credits. Health and accident insurance is characterized not only by classification of risks, but also according to whether entire groups are included in coverage. Where groups are included under a blanket policy, the rate structure may be adjusted from time to time to allow for the loss experience of the group.

Merit rating involves various costs to the insurance institutions: Extra actuarial work, complicated premium calculations, disturbed relations between insureds and between the company and insureds; additional clerical work due to changing rate schedules, and other costs that would not be incurred with fewer rate variations. If private insurance companies generally are willing to incur extra expense in offering merit-rating reductions in premium, it follows that there must be compensating gains.

Principal Objectives

Michelbacker, in defining merit rating stresses equity as one of the principle objectives of such rate adjustment:

> It may be defined, therefore, as a rating process which, when applied to the individual risk, measures the extent to which the particular risk deviates from the average of its class, and reflects this deviation in the rate for the risk. Its work begins where the work of the manual terminates . . . . In this way, a greater degree of equity is attained in rating, and the unfair discriminations which are inherent in a system of averages rates are at least partially removed. 2/

He presents two examples of risks with very different characteristics but in the same rate class.

> This treatment is neither equitable nor satisfactory, if proper rates are to be provided for the two risks, some extension of the rating program is required . . . . Merit rating provides this needed additional treatment. 3/

Because the rational business goal is to maximize profits, three other justifications for merit rating are probably of more interest to private insurance companies than that of equity between insureds:

1. For competition purposes: Merit rating provides a method of rate reduction to the insured that can be earned by him and would not as likely result in a rate war between companies. Merit rating is of most advantage to those companies who begin it first: It gives them a price advantage, and is an effective tool in attracting the lower risks. Since merit rating does in effect tend to eliminate inequities between risks, the company which initiates such rate reductions improves its relations with its insureds. The advantage decreases with the increase in the number of companies granting the credits. In some cases, the initial advantage is difficult for competing companies to overcome, if the innovating company is able to drain off a sufficient proportion of the better risks, and thus place the remaining companies in a position of being overloaded with the poorer risks and thus in a high loss

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2/ Michelbacker, op. cit., pp 231-232.

3/ Ibid., pp. 231-232.

situation. While competition is of little concern to the Federal Crop Insurance Corporation (at least with other companies in the field), the same points apply. The sale of any insurance, and hence the participation in the crop insurance program, depends upon rates relative to coverage or probability of loss and upon relations with present and prospective insureds. Also, crop insurance competes with alternative uses for farmers' income.

2. For combating the tendency toward self-insurance and adverse selectivity: The tendency to "self insure," or to use other means to protect against risk, is a partial function of the discrepancy between an individual's probability of loss and the average probability of the group, upon which the insurance rate is based. The higher the premium rate relative to an individual's estimate of his loss expectancy, the more likely he is to find other ways to handle his risk of loss. Since the rational individual will tend to prefer insurance as long as his rate is below his loss expectancy, the net effect of inequities is toward adverse selectivity, with the better risks not insuring or tending to drop out of the program. Merit rating is effective in narrowing the discrepancies. However, the problem is whether the premium base should be weighted (added to) sufficiently to balance the rate reductions, or should there also be rate <u>debits</u> for adverse loss experience in approximately the amount to bring in additional premium equal to the rate <u>credits</u> for good experience. The question will be discussed in more detail later.
3. For incentive to improve the risk: In types of insurance where the insured has the greatest control over his risk, and the loss-effect of such control is greatest, the incentive to improve is most important. The benefits accrue to all parties involved, and there are a minimum of problems involved.

The insured benefits from lower rates as well as from possible supplementary gains, such as minimizing chance of injury or loss of life, and consequential loss of business. This is particularly true in health and accident and fire insurance. The company gains by improving the quality of its risks and thus decreasing its loss ratios. In many instances it need not pass all the gain from lower loss ratios back to the insureds, depending upon competition and its costs of services involved in improving risks. Society gains by the lowering of net social and economic waste. Probably one of the most important points in favor of a rate reduction for loss prevention is that it does not involve a weighting of the base rate, nor rate debits to balance rate credits, assuming that the base rate represents an average loss expectancy of the insured group.

Forms of Merit Rating

Michelbacker groups merit-rate reductions under two general classes which depend upon whether the reductions are based upon *a priori* observed characteristics of the risk or based upon the *a posteriori* loss experience of the risk: 4/

1. Schedule-rating, or *a priori* rating, which takes account of physical factors responsible for differences between risks of the same class. Rate reductions of this type are normally independent of any record of loss experience of the subject risks, except as subsequent adjustments are made to conform to experience. The best-known example of schedule rating is in fire insurance. Dwelling fire rates are normally discounted according to whether the building is solid brick or frame construction. Commercial building rates are discounted or

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4/ *Ibid.*, page 237.

credited according to fire protection availability, construction, use, adjacent buildings, whether or not sprinkled, and size. In Federal crop insurance the credit allowed for size of insurance unit is a schedule-rate credit. Michelbacker points out two limitations that must be considered in applying schedule ratings: The peril factors for which credits are allowed should not be subject to constant change, and there must be only a few perils causing a high proportion of loss. 5/ One of the problems involved is that if the base rate is derived from an average of the risks within the group, there should be debits of approximately the same magnitude as the credits, or the base rate must be weighted to balance the credits. As a consequence, schedule rates must be adjusted in line with experience. If schedule rating is continued for a long period of time, the average risk tends to improve because the insureds have the opportunity to decrease their rates by risk improvement. In many cases, risk improvement is a gradual process before a point of rate reduction is reached. Until this point is reached, the insurer reaps the benefit of the improvement. Also it is a reasonable assumption that the insurer will tend to under-schedule rate, rather than over-schedule rate because of the degree of uncertainty involved.

2. Experience rating, or a posteriori rating, which relies on statistical records of past experience. Under this form there is no attempt to handle the risk experience by causes, or physical characteristics of the risk. Michelbacker describes its universality and basic advantages:

It is taken in its entirety, and because it reflects every loss-producing characteristic which has been responsible for losses in the past, it covers all types of hazards--tangible and intangible, physical, legal and moral. This gives experience rating a

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5/ Ibid., page 237.

universality of application which is impossible in schedule rating; risks of all classes which produce an experience having evidential value may be rated. 6/

Credibility

An important part of the theory of merit rating is credibility, which refers to the statistical reliability of a merit rate. As an illustration, Pfeffer postulates the self-insurer's calculation of his reserve against risk:

> If he merely adopts the loss portion of the premium for his risk classification from a current rate manual in setting up his reserves, he assumes that his risk has no peculiar features which make it better or worse than the class-rated risks. If he employs a rate which is less than the manual suggests, he implicitly assumes that his risk is, in some degree, better than average. In the event that his exposure to the particular hazard is different from the average in his classification because of factors which are not attributable to chance; if, for example, he has an unusually effective accident prevention program, is there any method available for measuring the "correct" premium adjustment which will take these exposure differences into account? This is one of the major problems which the actuarial concept of credibility is designed to answer. 7/

Credibility recognizes several important points to consider in the allowance of merit-rate reductions:

1. That in fairness to all insureds, merit-rate reductions should not be granted for experience differences due to random events --"good luck."
2. The greater the number of exposure units, the more accurately can the "good luck" experience be separated from differences due to individual risk characteristics:

> The deviations of the experience of individual risks, from the expected loss as indicated in the manual pure premium,

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6/ Ibid., page 237.

7/ Pfeffer, Irving, Insurance and Economic Theory, (S. S. Huebner Foundation, Univ. of Penn.) Richard D. Irwin, Homewood, Illinois, 1956, page 64.

may be due to either one of two factors: Random variations or differences in the exposure to hazard. This second element produces a bias in the statistics which the actuary is able to isolate. Any rate adjustments granted to individual risks should, in fairness to the entire class of insureds, be based on differences in exposure rather than upon the accidental "good luck" of the particular risk. According to the inferences drawn from the Laws of Large Numbers, the magnitude of the random or sampling errors declines as the number of observations (exposure units) increases. Hence, it follows that if a substantial error persists, it is unlikely that it is due to chance factors. 8/

3. The greater the peril (the number of loss incidents), the greater the dependability of the merit-rating calculations.

In other words, the credibility concept attempts to incorporate statistical methods as protection against allowing rate reductions for random, insurable perils or loss factors. The following remarks by Greene clarify the meaning and importance of credibility:

> A concept of basic importance in insurance rate making is credibility. In general terms, credibility refers to the degree to which the rate-maker can rely on the accuracy of loss experience observed in any given area. For example, assume that the rate-maker is faced with the task of revising a rate for a certain type of policy issued by his company in a given geographical area. There are 50 policies outstanding and the loss ratio on these policies indicates that losses have been considerably higher than anticipated. Should future rates be based on the experience of these 50 policies, or is there a considerable likelihood that the last year under consideration produced higher than average losses only by random chance? In other words, the rate-maker wishes to know the extent to which the experience is "believable." He wishes to know how many policies there would have to be before the loss experience observed should be given 100, 90, 80, 50 or 10 percent weight in preparing the rate revisions.
>
> The answers to these questions are of obvious importance not only to the insured but also the insurer. If upon the next renewal the rate-maker raised the insurance premium of everyone who had suffered a loss, the purpose of loss-spreading, which is inherent in the insurance mechanism, would be largely lost. . . .
>
> The statistical basis for the determination of what constitutes a credible number lies in the fact that losses in

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8/ Ibid., page 64.

> insurance are deemed to occur as independent random events and are more or less normally distributed. This means that we can determine the number of "trials" in a sample necessary to produce, with some predetermined degree of accuracy, a loss ratio which falls within some stated error range of the expected loss ratio. 9/

Actuaries in various insurance fields have developed credibility formulas from which credibility tables are constructed to provide merit-rate adjustments. According to Pfeffer, the credibility table has the following characteristics:

1. The minimum credibility is zero, but this weight is assigned to all risks having less than some arbitrarily determined amount of exposure.
2. The maximum credibility is 100 percent, and is assigned to all risks having in excess of an arbitrarily determined amount of exposure. Such risks are termed "Self-Rated." Inasmuch as random error can never be entirely eliminated, the idea of 100 percent credibility is statistically unorthodox to say the least.
3. Risks with intermediate exposure volume are assigned credibilities in accordance with their numbers of exposure units.
4. On the basis of an extensive mass of data for the particular classification, the degree of credence assignable to the individual's loss experience may be objectively determined. This procedure minimizes the role of personal judgment in establishing equitable rates for individual risks. 10/

He summarizes his discussion of credibility:

> The use of the credibility approach is a recognition of the fact that the Laws of Large Numbers, which provide the rationale of the sampling technique, require a set of conditions which are, in principle, impossible of attainment. It is an attempt to effect a compromise between the requirements of orthodox statistics and the judgment of the rate-maker. 11/

9/ Greene, Mark R., Risk and Insurance, Southwestern, Cincinnati, 1962, pp. 720-721.

10/ Pfeffer, op. cit., pp. 65-66.

11/ Ibid., page 66.

Judgment Rating

Up to this point the implication is that all insurance risks lend themselves to statistical methods. However, there are some risks that because of special characteristics are not amenable to statistical tests or precise actuarial methods. Probably no line of insurance fulfills all the requirements of sampling theory, but some come much closer than others, according to Pfeffer:

> Automobile Public Liability Insurance employs car-years as the unit of exposure and meets the tests of mass and a clearly defined collective, but is less satisfactory in terms of the homogeneity of its loss-causing potential; Life insurance, similarly, is weak on risk homogeneity; Workmen's Compensation Insurance is subject to a serious catastrophe hazard as is Fire Insurance. Unemployment Insurance fails to meet any of the tests except that of mass. The evident failure of the actuary to solve the problem of application has led to a reluctance to adopt statistical rate-making procedures in some lines and indeed, there are tendencies at the present time favoring a return to a greater emphasis on judgment even in those lines where it is customary to adopt a statistical approach. 12/

Judgment rating fills the gap in rating procedures between the purely statistical basis for an insurance rate and the taking account of the risk factors that cannot be handled by sampling theory. Little insurance would ever have been written had not judgment rating been combined with actuarial methods. In fact, in many types of insurance, judgment rating necessarily preceded accurate statistical methods during the interval while the empirical data were being accumulated during the early years of an insurance program. Probably little data were collected on dwelling fires until after insurance had been written for several years on a judgment basis. This situation is a characteristic of all-risk crop insurance: Prior to 1939 the best data available were gathered and analyzed, to which statistical methods were applied as precisely as the data warranted. Now 25 years of additional data have been compiled from the Corporation's experience, and

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12/ Ibid., pp. 66-67.

combined with the original data. But there remains insufficient data to provide the desired accuracy for rate making. The data are especially insufficient for precision in experience rating; 25 years experience does not mean that all present insureds have experience records of 25 years available for use of the Corporation. Consequently, merit rating in all-risk crop insurance necessarily combines statistical methods with judgment rating.

The general process of judgment rating is "pitching" a base premium at a level that is presumably high enough to cover the worst loss expectancy for the class of risks that are to be insured (including expenses and profits, in the case of private insurance). Then for a particular risk or sub-group of risks, debits and credits are applied according to the relative significance of various risk factors on a judgment basis. Schedule rating of commercial property for fire insurance is an example of widespread use of judgment rating. The principle reason for its use in this field is the lack of homogeneity of risk units and the extreme magnitude of potential loss per insured unit relative to the probability. In the case of Ocean Marine Insurance, the use of judgment rating is necessary because "the personal equation--the integrity of the shipowner, the skill of the ship's officers, and the quality of the crew, is paramount." 13/ In other words, many immeasurable risk factors are of relatively high importance.

In all-risk crop insurance, as well as in some other types, the merit-rate reductions may have an important effect on the selection of risks because of psychological as well as economic reasons. This effect is of paramount importance, and because the effect is empirically immeasurable, at least with present experience, rate reductions require a considerable degree of judgment rating.

Information from the FCIC indicates that its size and experience rate reductions have been a matter of "administrative decision," which without

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13/ Ibid., page 68.

further information would infer that the discounts were purely a matter of judgment. They could hardly be otherwise since it takes several years to determine a pattern of reaction to rate reductions, or even to determine their effects on the actuarial rate calculations. Only under the present research projects, such as GP-8, are extensive and systematic studies being made of insureds' reactions to various FCIC policies. The complications revealed by these studies are expected to add to the fund of experience from which more precise rates and rate adjustments can be made.

However, an insurance program as young as Federal crop insurance should apparently not despair just because it lacks data on which to determine rates purely statistically. As noted above, all the older lines of insurance, including Life and Fire, fall short of at least one of the important requirements of sampling theory. Pfeffer, in this part of his discussion, includes the footnote:

> That the actuary has by no means given up the attempt to solve this problem is evidenced by a wealth of articles in the technical journals. Examples include: Carleton, who explores the implications of non-randomness; Walsh, who attempts to deal with nonhomogeneity; and Mowbray, who explores the problem of inadequate mass. 14/

and in connection with commercial fire insurance, which is about the oldest line of insurance, except marine:

> ... statistics can never give us the slightest clue as to the adequacy of these charges or credits (in the fire schedules). The causes of most fires cannot be ascertained, but that is the relative contribution of any one of these analyzed parts to the total hazard found in each risk. An instant's thought will show that we are forever precluded from obtaining, through classified statistics, the contribution of such factors as area, height, wall thickness, floorway openings, classified combustibility, labor, motor power devices, or any other of the features of hazard enumerated in a modern tariff. It is hopeless to look for any help in tariff construction from classified statistics . . . and we are inexorably and for all time thrown back upon some other method of establishing adequate estimates for these factors." 15/ (From A. F. Dean, "Fire Hazard, Is it Measurable?")

14/ Ibid., page 66.
15/ Ibid., page 66, footnote 27.

As long as the Federal crop insurance program is on an experimental basis, judgment will play an important part in the development of its rates, and especially in connection with merit rating. It would be very desirable to reserve rate adjustments for application after a substantial period of experience. However, as with other types of insurance, the problem of participation and relationship with insureds does not allow time for statistical experience.

To the extent that judgment is flexible and forward-looking, while experience and statistics are backward looking, judgment rating has the advantage of adjusting to changing conditions more quickly, and sometimes more accurately than statistical methods of rating. For example, if a breakthrough occurred in hybrid wheat that would within two or three years raise average yields 50 percent, the effects could be immediately estimated and rate changes made accordingly. Likewise, if some new malady showed up that would make disease instead of drouth the primary crop-loss factor, a judgment of its effect could alleviate future rate difficulties until such time as experience provided more accurate statistical information.

Retrospective Rating

Retrospective rating is another form of rating that recognizes individual differences between risks, and therefore falls under this general classification of merit-rating programs. Its principle use is in workmen's compensation insurance, especially designed for employers of large numbers of workers, limited to a minimum size payroll. However, there is the possibility that retrospective rating has certain characteristics that make it adaptable to certain situations involved in crop insurance.

This type of rating is a combination of schedule, experience and judgment rating. Its distinguishing characteristic is that the net rate is calculated completely *a posteriori*, usually at the end of each year, based on the experience of that year. In the usual experience-rating process described above, the rate is based on experience but determined for the ensuing year, and the past year's rate is not altered for the experience

during the year for which it was established. The usual procedure used in retrospective rating is as follows: The risk is first surveyed and analyzed according to loss-causing factors. By comparing the situation with similar types of risks and applying judgment, an initial premium deposit is charged. The insurer is usually protected by setting this initial deposit high enough that it will more than cover what appears to be the loss expectancy of the risk plus a safety margin. In the case of workmen's compensation insurance, a rate per $100 payroll is usually set, which sets a maximum premium charge as a protection to the insured against an abnormal premium cost. At the end of the year, the actual total indemnities are calculated and paid by the insured, subject to maximum and minimum charges set by the contract. Rates and deposits are adjusted from time to time according to the loss experience. Normally, a sizable deductible is established, which has the effect of decreasing the minimum premium and service charges levied by the insurer. In some cases, a group is the basis for the retrospective rating.

The Present Federal Crop Insurance Program

Premium Reductions Available for Experience

A total reduction of 50 percent from the standard rates can be earned by wheat farmers for good loss experience under the Federal crop insurance program. Section 3 (b) of the wheat endorsement provides for experience reduction:

> 3. Annual Premium
>
> (b) Whether or not the insured is eligible for the reduction provided in section 4(b) of the policy, the insured's annual wheat premium may be reduced in lieu thereof for any year by not to exceed 50 percent if it is determined by the Corporation that the accumulated balance (expressed in bushels) of premiums over indemnities on consecutively insured wheat crops preceding the current crop year equals or exceeds his total bushel guarantee based on the amount per acre shown on the county actuarial table.

The section 4 (b) of the policy referred to above in section 3 (b) provides for a maximum experience rate reduction of 25 percent:

4. Annual Premium

(b) The insured's annual premium for an insured crop shall be reduced 5 percent if he has had three consecutive years of insurance on such crop immediately preceding the current crop year (eliminating any year in which a premium was not earned) without a loss for which an indemnity was paid. For each such additional consecutive year of insurance on such crop without a loss for which an indemnity was paid, the insured's annual premium shall be reduced an additional 5 percent, except that the total reduction shall not exceed 25 percent. If an insured has a loss on a crop for which an indemnity is paid, the number of such consecutive years of insurance on such crop without a loss for which an indemnity was paid shall be reduced by 3 years; Provided, that, where the insured has 7 or more such years, a reduction to 4 shall be made and where the insured has 3 or less such years, a reduction to zero shall be made.

Several features distinguish the latter policy premium reduction formula from that of the wheat endorsement. Figure 15 is a scale of the premium reductions allowable under Section 4(b) of the policy, showing the reductions available after given consecutive years of zero indemnity payments, and also how the experience record and reductions are affected by indemnity-payment years. An insured under this scale begins to accumulate premium reductions after three consecutive years of zero-indemnity payments. He can earn up to 25 percent reduction in premium if he has seven consecutive years of zero-indemnity payments. For every year in which he has an indemnity payment under the policy, he loses three of his consecutive zero-indemnity years, but his record of such years cannot be reduced to less than zero (e.g. If he had 10 consecutive years, his record would show 7, the maximum then, following a year with a loss, his record would be reduced to 4 years.) Also, once he accumulates a record of seven or more consecutive zero-indemnity years his record cannot be reduced to less than four such years; in other words, his premium reduction could not be decreased to less than 10 percent.

That there are no debits to the base premiums is an important point to keep in mind in this study of present crop-insurance merit rating. The provisions of the policy, as well as those of the wheat endorsement, provide only for reductions from (credits to) the base premiums. The earned

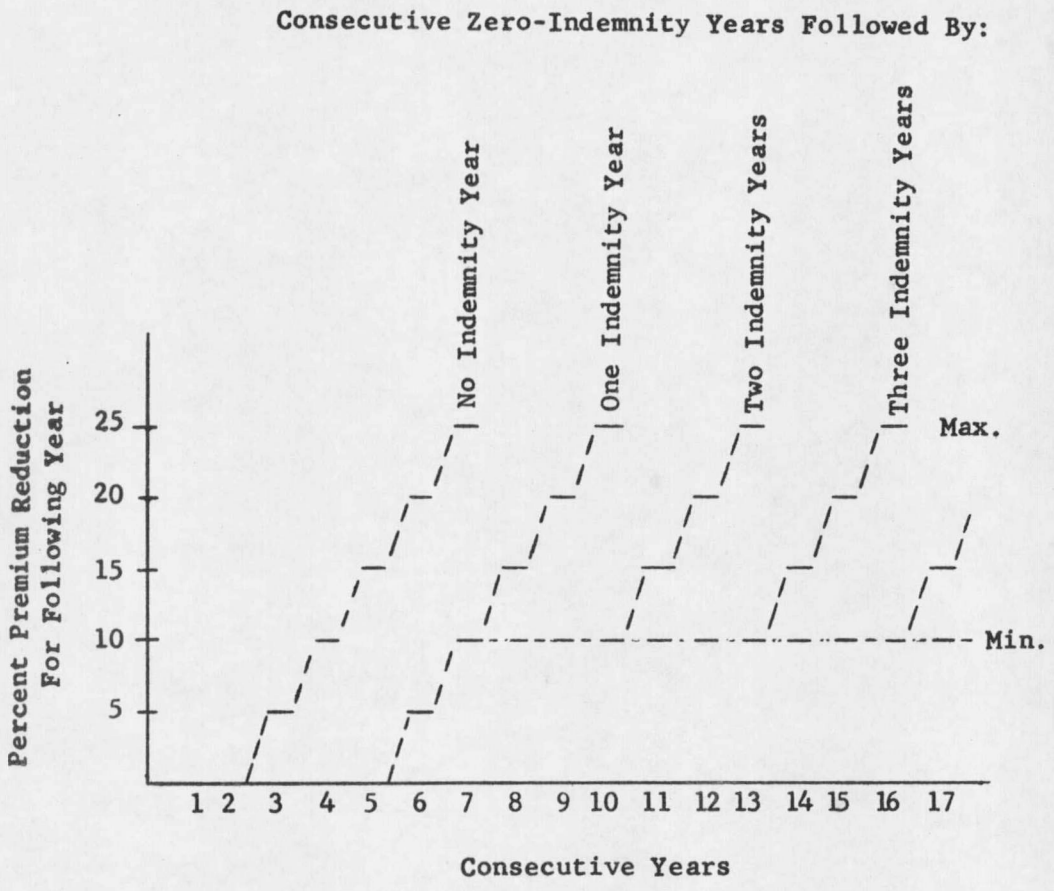

Figure 15. Scale of Premium Reductions Under Policy Sec. 4 (b).

debits can apply only against earned credits; thus premiums can in no case be raised above the base rate for the area in which an individual risk is located.

Inconsistencies Under the Experience-Credit Formulas

Under the provisions of both the policy and wheat endorsement, an insured will receive the benefit of the formula which gives him the highest premium reduction according to his loss record. For example, if an insured has a small loss every other year or so, he could not have earned a credit under the policy formula, but could have accumulated enough net premium credit to qualify for the 50 percent credit under the wheat endorsement formula. On the other hand, an insured that had a complete loss in say 1953, but no losses since would have earned a credit of 25 percent, but have accumulated little if any reserve toward a 50 percent credit under the wheat endorsement formula.

The use of these formulas has created some peculiar situations as revealed by the records of some Montana insureds who have been in the program continuously from 1947 to 1963. Ten of these insureds were selected from each of Blaine, Chouteau, and Sheridan Counties, and their loss and premium credit records were summarized according to the Tables XIX, XX, and XXI. (The farmers' names have been coded by initial of county and number.) As one compares the net loss experience, the number of loss-free years, and the longest run of loss-free years with the number of years of 50 percent credit, between various insureds in one county, inconsistencies become apparent. For instance, compare B14 (who had a net premium credit of 3,865 bushels, 15 loss-free years out of 18, and a longest loss-free run of 11 years, but had earned only three years of 50 percent credit under the formulas) with BL-10 (who had a net premium debit of 1,962 bushels, only 12 loss-free years out of 17, and a longest loss-free run of only 6 years, but had earned seven years of 50 percent premium credit).

Inconsistencies can also be found when comparing insureds from high-risk areas with those from low-risk areas. Table XXII compares Ch5 from Chouteau County with Sh7 from Sheridan County. Both of these insureds

TABLE XIX. FCIC INSUREDS IN BLAINE COUNTY, MONTANA: PREMIUM, INDEMNITY AND PREMIUM-CREDIT RECORD.

Insured's Code		BL-1	BL-2	BL-3	BL-4	BL-5	BL-6	BL-7	BL-8	BL-9	BL-10
Period Covered		1945-63	1945-63	1945-63	1945-63	1945-63	1945-63	1945-63	1946-63	1946-63	1946-63
Total Premium (1)	(bu.)	3,430	10,893	4,065	6,058	1,809	7,208	11,212	3,452	11,855	8,756
Total Indemnity (2)	(bu.)	1,065	10,418	1,502	2,193	1,205	11,070	16,040	202	6,911	10,718
Balance of Premium:											
(1) - (2)	(bu.)	2,365	475	2,563	3,865	604	-3,862	-4,828	3,250	4,944	-1,962
FCIC Account a/	(bu.)	2,616	3,613	2,946	4,285	957	3,808	3,567	3,591	9,261	4,555
Loss-Free Years											
Total	(yrs.)	15	13	18	15	13	12	10	16	12	12
1963 FCIC Acc't.b/	(yrs.)	14	2	6	6	5	11	2	15	12	5
Longest Run	(yrs.)	14	11	15	11	12	11	6	15	12	6
Experience Reduction											
1963	(pct.)	50	50	50	15	50	50	0	50	50	50
Beginning Year		1955	1955	1951	1957	1955	1958	1955	1953	1959	1956
No. of Years of:											
50%		9	7	8	3	9	6	4	11	4	7
25%		-	2	5	2	-	-	-	-	1	-
20%		-	-	-	-	-	-	-	-	-	-
15%		-	-	-	1	-	-	-	-	-	-
10%		-	-	-	1	-	-	-	-	-	-
5%		-	-	-	-	-	-	-	-	-	-

a/ Premium reserve toward experience credit under wheat-endorsement formula is per FCIC record (negative cumulative balances were ignored in the FCIC formula).

b/ This is the total credit of loss-free years according to the policy formula. (e.g., B12, beginning in 1950, accumulated on his FCIC record 11 loss-free years. In 1961 he had a loss, losing 3 years of credit. Since 7 years is maximum credit, his book record showed 7 - 3 = 4 years for the 1962 crop.)

TABLE XX. FCIC INSUREDS IN CHOUTEAU COUNTY, MONTANA: PREMIUM, INDEMNITY, AND PREMIUM CREDIT RECORD.

Insured's Code		Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10
Period Covered		1946-63	1946-63	1946-63	1945-63	1945-63	1946-63	1946-63	1946-63	1946-63	1946-63
Total Premium (1)	(bu.)	2,873	7,257	2,435	11,567	7,088	2,848	7,741	10,629	3,349	3,072
Total Indemnity (2)	(bu.)	1,988	1,566	1,198	7,720	2,917	339	197	11,791	481	0
Balance of Premium:											
(1) - (2)	(bu.)	885	5,691	1,237	3,847	4,171	2,509	7,544	-1,162	2,868	3,072
FCIC Account a/	(bu.)	1,193	6,840	1,236	4,069	3,424	3,432	7,543	0	2,867	3,070
Loss-Free Years											
Total	(yrs.)	16	13	14	12	17	17	16	15	16	18
1963 FCIC Acc't. b/	(yrs.)	8	10	5	0	1	13	11	0	5	18
Longest Run	(yrs.)	8	10	12	7	17	13	11	14	14	18
Experience Reduction											
1963	(pct.)	25	50	10	0	10	50	50	10	10	25
Beginning Year		1960	1958	1957	1957	1957	1948	1958	1952	1955	1953
No. of Years of:											
50%		-	6	-	5	-	9	6	3	3	1
25%		1	-	6	1	6	1	-	5	5	10
20%		1	-	-	-	-	-	-	-	-	-
15%		1	-	-	-	-	-	-	-	-	-
10%		1	-	1	-	1	1	-	3	1	-
5%		-	-	-	-	-	-	-	-	-	-

a/ Premium reserve toward experience credit under wheat-endorsement formula is per FCIC record (negative cumulative balances were ignored in the FCIC formula).

b/ This is the total credit of loss-free years according to the policy formula.

TABLE XXI. FCIC INSUREDS IN SHERIDAN COUNTY, MONTANA: PREMIUM, INDEMNITY, AND PREMIUM-CREDIT RECORD.

Insured's Code		Sh1	Sh2	Sh3	Sh4	Sh5	Sh6	Sh7	Sh8	Sh9	Sh10
Period Covered		1945-63	1945-63	1945-63	1945-63	1945-63	1945-63	1945-63	1946-63	1946-63	1946-63
Total Premium (1)	(bu.)	3,390	3,350	3,682	6,472	8,538	6,674	8,586	14,093	5,590	4,100
Total Indemnity (2)	(bu.)	1,666	646	1,125	1,215	7,217	936	6,755	5,974	3,038	0
Balance of Premium											
(1) - (2)	(bu.)	1,724	2,704	2,557	5,257	1,321	5,738	1,831	8,119	2,552	4,100
FCIC Account a/	(bu.)	1,722	2,704	2,556	5,496	1,320	5,738	4,067	8,128	2,850	4,099
Loss-Free Years											
Total	(yrs.)	16	16	16	17	13	17	16	16	14	18
1963 FCIC Acc't. b/	(yrs.)	6	2	2	9	2	9	6	14	11	18
Longest Run	(yrs.)	14	7	6	9	5	9	7	14	11	18
Experience Reduction											
1963	(pct.)	15	50	50	50	0	50	50	50	50	50
Beginning Year		1950	1950	1954	1954	1956	1957	1956	1957	1959	1950
No. of Years of:											
50%		11	14	15	7	2	5	7	7	2	16
25%		1	-	-	1	-	-	-	-	3	1
20%		-	-	-	-	-	-	-	-	1	-
15%		1	-	-	-	-	-	-	-	-	-
10%		1	-	-	-	-	1	-	-	-	-
5%		-	-	-	-	1	-	-	-	-	-

a/ Premium reserve toward experience credit under wheat-endorsement formula is per FCIC record (negative cumulative balances were ignored in the FCIC formula).

b/ This is the total credit of loss-free years according to the policy formula.

were somewhat comparable in size of total premium payment, the total credit shown on the books of the FCIC, and number of loss-free years. But note that Ch5 (from the lower risk area) was a much better risk according to: The total excess of premiums over indemnities for the total period, and the longest consecutive run of years. However, Ch5 had earned only 10 percent premium reduction by 1963 as compared with 50 percent for Sh7, had received no years of 50 percent reduction as compared with seven years for Sh7, and reductions began in 1957 as compared with 1956 for Sh7.

Here is how the record would have looked under different circumstances: Sh7 had a bad loss in 1945, with little premium paid in. But in accordance with the rules, no negative balance was carried forward. Had it been carried forward, his total premium would never have equalled his indemnities, and he would therefore have received no 50 percent reduction in the 18 years, only one year of 25 percent, and seven of less than 25 percent.

On the other hand, had Ch5, similarly to Sh7, experienced his worst year (1962) in 1945, and had this loss been dropped from the record, he would have recieved a 50 percent credit in about 1957 and continued this credit through 1963--a total of seven years of 50 percent premium reduction.

It is important that the two formulas be analyzed separately in order to determine what they mean in reference to the theory and objectives of merit rating.

The 50-percent wheat-endorsement formula.--This formula premises that once the insured has paid premiums in an amount equivalent to a total year's liability in excess of indemnities received, and as long as his subsequent indemnities are covered by subsequent premium payments, a 50-percent reduction in premium is a reasonable credit for his control over his losses and other non-random factors accounting for his better-than-average experience. The time it takes to earn this discount varies from 5 to 18 years, depending upon the rate area and price level chosen. For example, the rate in Area 1, Dawson County, for 6.5 bushels per acre coverage at $1.50 per bushel ($9.75 per acre coverage) is $2.00 per acre. Compare this with Area 4, Chouteau

TABLE XXII. COMPARISON OF TWO INSUREDS' LOSS AND CREDIT EXPERIENCE, FROM CHOUTEAU AND SHERIDAN COUNTIES.

	Insured's Code	
	Ch5	Sh7
Years	1945-63	1945-63
Total Premium (bu.)	7,088	8,586
Total Indemnity (bu.)	2,917	6,755
Excess of Premium over Indemnities (bu.)	4,171	1,831
Credited on FCIC Account (bu.)	(3,424)	(4,067)
Loss-Free Years		
On Account	(1)	(6)
Longest Consecutive Run	(17)	(7)
Experience Reduction		
1963	10%	50%
No. of Years:		
50%	0	7
25%	6	0
10%	1	0
Beginning Year	1957	1956

County, where the rate for 13.0 bushels per acre coverage at $2.25 per bushel (or $29.25 per acre coverage) is $1.60 per acre.

After an insured has earned his 50-percent discount, if he has a loss that reduces his net excess of premiums below his total liability, he loses all of his 50-percent discount (ignoring for the time being the application of the other formula). This means that his rate is doubled. This point is

important to future analysis of the FCIC rating procedure: The insured's rate is discounted 50 percent for good experience, but after having had the discount for several years, his rate is increased 100 percent or doubled for bad experience. Another point is vital to flexible rate management: The wheat-endorsement experience rating formula is an all-or-nothing proposition; the rate credit is either 50 percent or nothing.

It is probably a correct assumption that this type of rate reduction was adopted for its administrative simplicity--a factor not to be belittled. But it is of importance to analyze what an all-or-nothing rate reduction of this magnitude means in insurance-rating theory. The function of rate credits is to create rate equitability between insureds, taking account of non-random factors affecting risk probability which make the individual's loss expectancy less than that of the group average. These factors would include such things as better management, better climatic conditions, greater dispersion of the unit, and better soil. An all-or-nothing rate reduction of 50 percent premises that an insured proves by his experience that he has a 50 percent better loss expectancy or significant difference from the average. Conversely, it should mean that if he losses his experience credit, something has happened to change appreciably the factors that gave him the good experience in the first place. If these factors have not been changed, his rate reduction is being withdrawn because of bad luck. The procedure is doing what Pfeffer said merit rating should not do, allowing rate changes for "good or bad luck." It would be easy to fall into this trap in crop insurance, because of the lack of data to provide the statistical tests for credibility. Also, the desire for better participation places strong pressures to apply the use of experience credits even when they may not be justified on a theoretical basis. This author has noted that this has been the cause of failure of some private insurance companies, especially new ones trying desperately to develop a volume of good business against entrenched competition.

The 25-Percent Policy Formula.--The type of experience rate reduction which is built into the policy is characterized by more gradual changes

upward and downward, and by the maximum reduction limit of 25 percent. The reduction is independent of the relationship between amount of premiums and indemnities paid. Rather, it depends only upon the number and sequence of indemnity-free years. Again, if the theoretically acceptable justifications for merit rating are applied, this formula premises that if an insured has three consecutive indemnity-free years, there is a high probability (how high, we don't know) that his good experience is due to factors other than "good luck." As indemnity-free years continue to accumulate, his loss expectations due to other than "good luck" continue to decrease at the rate of 5 percent per year up to a maximum of 25-percent reduction. A 25-percent maximum reduction assumes that these factors cannot account for more than 25 percent of the basic rate, or at least that the insurer is not willing to make allowance for any more. When loss of rate credits for loss years is compared with the earnable rate reductions, the assumptions appears to be that bad experience is more indicative of loss expectancy than good experience, or else that the insured has enough control over his risk that a penalty should have a beneficial effect on the insured's loss ratio in some way. This reasoning follows from the fact that each indemnity year causes a loss of three indemnity-free years. However, there are no debits against the basic rate. In other words, the insured's rate can never be raised above his basic rate. Also, after having earned a record of seven loss-free years (having earned the maximum credit of 25 percent) the merit-rate reduction cannot be decreased below 10 percent--regardless of whether there are significant unfavorable changes in the individual's special risk factors, his experience credit cannot be reduced below 10 percent, assuming his contract, his unit and the law to be unchanged.

The Formulas Combined.--As pointed out previously in this chapter, and illustrated by Tables XIX to XXII, the two formulas are applied according to whichever is most favorable to the insured, at least through the 1965 crop. Inconsistencies thus created indicate that the application of the formulas does not accomplish the theoretical purposes of

merit rating. Not only does the use of both formulas together retain the features of either formula applied exclusively, but also they appear to create more inconsistencies between insureds with little if any gain in theoretical conformity.

However, an important point is that in reformulating experience credits to conform better to their purpose, the two basic premises of the present formulas should be taken into account in the new formula: (1) That the number of loss-free crop years is one partial indicator of non-random differences between individual insureds; and (2) that the payment of premiums in excess of one-year's insurance liability is another partial indicator of non-random differences. The error in the present system is that each of these premises are considered sufficient in the formulas taken separately, and both are sufficient when taken together. Much more consideration should be given to other indicators of non-random differences, and also to eliminating the effect of random occurrences as they affect an individual's experience credits.

Area-Wide Loss and Experience and Individual Experience Credits

A special problem that is not solved by present experience-credit formulas is the effect on individual credits resulting from area-wide random loss-causing phenomena. An example is the following hypothetical situation: Suppose that under the present formulas, 20 percent of the insureds of Chouteau County, Montana, had earned a 50 percent experience credit, which theoretically reflects non-random differences (such as superior management) between these insureds and the other long-time insureds in the county. Then suppose that a drouth and later a hailstorm almost completely destroyed the crops in most of Chouteau, Cascade and Judith Basin Counties. It is conceivable that under present formulas this situation would result in a large proportion of the 20 percent (earning the 50 percent credit) to lose their experience credits, or at least to have them reduced to 25 percent, due to this random occurrence, which is in no way related to the non-random differences for which they were granted the experience credit in the first place.

If this problem is to be solved, the merit-rating formulas must be revised to avoid the effects of occurrences which affect all insureds within an area alike, and which are not related to the differences between insureds for which a merit rate was granted. A suggested change in the formula would be to discount an individual's loss record (for merit-rating purposes) according to the area loss ratio. By this method he would not lose his experience credit in a year when all insureds in the area experience losses.

Premium Reduction for Size of Unit

In addition to rate reductions for experience, the wheat endorsement provides for a further reduction of from 4 to 20 percent for the size of the insurance unit, Section 3 (a):

> 3. Annual Premium
>
> (a) There will be a reduction in the annual wheat premium for each insurance unit of 4 percent for the first full 200 acres of insured wheat acreage on the unit and an additional 2 percent reduction for each additional full 100 acres; Provided, however, that the total reduction shall not exceed 20 percent.

This type of rate reduction is a function of one risk factor, size of the insured unit, and premises that the size of a unit has some effect on the loss expectancy of that unit. (In private insurance, an important size effect is improved administrative efficiency--more premium per unit of clerical and administrative cost. This latter effect is important to the FCIC as it pertains to appropriations, but not to rate calculations, since the rates are not required to cover administrative costs.) The size effect on loss expectancy can arise from two phenomena, (1) the relationship between size of the unit and the efficiency of management, and (2) relationship between size and the incidence of loss-causing perils.

Observation seems to indicate that there is some tendency for large farm units to be operated more efficiently than small ones. If this is true, the reason may be that the more successful operators tend to accumulate more capital and are able to enlarge their units. Whatever the cause, the increased efficiency, if it exists, might justifiably be recognized by the size-credit formula. On the other hand, the experience-credit formula

would take account of most efficiency differences, except possibly in the case of the few extra-large units.

The other factor related to the size effect on loss expectancy is the relationship between size and the incidence of perils, the assumption being that the larger the unit, the less is the variance in total yields due to crop perils. The premise appears to be sound, except that dispersion is probably more important than size. For example, the nature of hailstorms is such that one storm is much more likely to completely ruin a 160-acre field that is one-half mile square, than one that is one-quarter mile wide and extends a mile from north to south (see Chapter VI). Attempts have been made to measure the effects of dispersion, with moderate success. Jensen and Nash stated as follows in their summary:

> Farm dispersion is not considered as a method of avoiding hailstorms, but is an attempt only to reduce the impact of these storms in any one year. In total, dispersion may be looked upon as an adjustment to the aggregate effects of all climatic factors influencing yields, not just hail alone. It is expected that over a period of years the dispersed farm will lose the same total acres of grain to hail as the non-dispersed farm, but, at the same time, reduce the fluctuations from year to year.
>
> . . . . . .
>
> A general conclusion from this analysis is that in some years farm dispersion does not influence yield variability. In other years, variability decreases significantly for those farms with less than 1,000 acres in wheat as the dispersion distance is increased, until a distance of up to 15 miles is reached.
>
> When analyzed over time, dispersion was concluded to be an effective technique in reducing yield variability except on those farms which had 1,000 acres of wheat or more. 16/

Solving Problems with Merit Rating

The hypotheses stated at the beginning of this chapter were that merit rating could be used to better advantage than it is now used in solving the

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16/ Jensen, C. W., and Nash, D. A., Farm Unit Dispersion, Mont. Agr. Exp. Sta., Mont. State. Col., Bozman, Mont., in cooperation with Farm Econ. Div., ERS, USDA, Technical Bulletin 575, Apr., 1963.

problems encountered in crop insurance, which arise out of individual differences between risks; and that these rate reductions for individual risk differences can be used to accomplish certain purposes only if they are closely related to the purposes for which they are intended. Merit rating can be used to better advantage in solving such problems as participation, adverse selectivity, defining the insurance unit, area delineation and most important, differences in management.

Participation in the Program

A high degree of participation is an important concern in any insurance program because of the optimum application of the Laws of Large Numbers, if for no other reason. The larger the number of insureds and the greater the spread over different crops and over a wide area of the country, the more accurately can crop-loss probabilities be estimated, and the less will be the effect of local adverse conditions. The advantages of mass participation are no less important in crop insurance than in any other type of insurance. In addition to the operational or economic advantages of extensive participation, there are also the public service advantages, especially important in the case of Federal crop insurance, since it is a publicly subsidized agency. The more accurately the FCIC can relate premiums to losses, the better it can extend its services into other crops and areas, and the more accurately it can establish equitable rates. Participation is a measure of FCIC's success and therefore a factor in justifying continued public subsidy.

There is concern that the present experience-rate formulas might be more of a hindrance than stimulant to participation. Again, since there are no debits against, but only credits to the base rates, the latter must be weighted to balance the experience and size credits. Thus, premiums for the new insured are higher than the average actuarial risk, and will look especially high to him if he is able to compare them with those for an insured who has earned a high experience credit. The result is that the experience credits help to retain the insureds who have earned them, but are a deterrant to enrolling new insureds, and also may cause present

ones to leave when their premiums are increased 75 to 100 percent as a result of losses causing forfeiture of their experience credits.

Merit rating can be improved in solving this problem by revising the formula to make it more equitable. Several points must be considered: (1) Indicators of good and bad risk should be selected and given proper weight in a formula. Among these indicators would be net of premiums over indemnities, relative number of loss-free years and maximum runs of loss-free years, whether large indemnities were due to general conditons that struck all insureds in the area, and whether a large loss was purely random. (2) The formula should produce reasonably consistent results as between insureds, at least within the same rate area. (3) Related to these two requirements is the need to recognize that merit rating gives credit for the existence of individual differences; a credit should be withdrawn only on the basis of an unfavorable change in these individual differences. (4) The formula should recognize the sales potential of giving experience credits, and the sales detriment from removing them. The tendency should be to build them slowly and soundly, rather than too rapidly and precariously. (5) Consideration should be given to incorporating experience debits as well as credits. This would tend to lower the base rate for new insureds, and provide an alternative to underwriting an insured out of the program.

A proposal that should be considered in conjunction with other uses of merit rating is to reduce the base rate for a new insured if he can prove a favorable loss-cost history according to a given formula. Individual records have improved sufficiently in the past 25 years (through participation in agricultural programs) to make a beginning rate reduction feasible.

Adverse Selectivity

Closely related to the problem of participation is the problem of adverse selectivity, also common to all types of insurance. The premiums are calculated on the assumption that the population of insureds is representative of the total population, and that, if it isn't, proper weighting

can be incorporated in the premiums. If experience and size credits affect participation in the program, it is very important to know whether the effect is biased, especially adversely. There is concern that the low-risk producer with a large, widely extended operation is averse to entering the crop insurance program because the beginning rates are too high relative to his estimate of his risk. Likewise, the high-risk producer with a small operation may not feel so strongly that the premium is too high relative to his risk, and he knows he has the opportunity for earning experience credits if he has good luck. If there is some tendency for the larger insureds not to enter the program, this may be the reason.

If the rating system has an adverse affect on participation in the early stages, and rate changes are made to adjust premiums to indemnities on the basis of adverse loss experience, adverse selectivity would be gradually increased. How merit rating is formulated can be significant in either causing or preventing adverse selectivity.

The methods suggested for the improvement of merit rating with respect to participation would apply to adverse selectivity. If the problem appears to be that of not including a sufficent portion of the extra large operators, other types of merit rating can be considered, such as retrospective rating. The principal function of retrospective rating is to evaluate the risks for units which, because of size or other unusual characteristics, fall outside the normal distribution upon which rates are based. An example would be the Campbell Wheat Farms in Montana.

Insurance Unit

The definition of an "insurance unit" has been changed in the last two years, presumably to allow for the favorable effects of dispersion of the farm unit upon loss expectancy, particularly from hail. Previously, the insurance unit was unequivocably defined according to the identity of ownership and operation, and also location. Later, the definition was broadened to allow for separation in handling the crop as an additional

basis for defining units. 17/ The most recent change of the definition allows more discretion on the part of the Corporation and the insured as to what constitutes an insurance unit. The result has been lack of uniformity between administrative areas, and in some cases an accumulation of excessive indemnity payments.

The problem arises out of establishing an a priori schedule-rating system based on an insurance unit that cannot be clearly defined and is subject to considerable equivocation. The problem becomes that of deciding where units can be divided, and of providing workable rules for handling and segregating the product. For this system to work properly, it is necessary to relate the definition of insurance units to the loss-probability benefits of dispersion.

To solve this problem it is recommended that the insurance unit be defined as before, based on precise definitions of ownership and operator. The formula for size-rate reduction should be revised to include the dispersion factor. Any residual effect of size and dispersion would then be absorbed in the loss-experience rate reduction. The author was informed by Montana State office of FCIC that in many cases in Montana the insured found that, when he considered net advantages to be gained by dividing his insurance unit, he would be better off if he kept the larger unit. By division, he runs a greater chance of losing some of his experience credits, in addition to losing size credits.

17/ Under Part 401--Federal Crop Insurance, Subpart--Regulations for the 1961 and Succeeding Crop Years, Wheat (Approved Jan. 30, 1962) Sec. 7 (a) "Insurance Unit," The Act now reads: "'Insurance unit'", notwithstanding section 21(g) of the policy, means the insurable acreage of wheat in the county in which (1) one person at the time of planting has the entire interest in the crop, or (2) the same two or more persons at the time of planting have the entire interest in the crop: Provided, however, the Corporation and the insured may agree in writing before insurance attaches in any crop year to divide the insured's insurable acreage of wheat in the county into two or more units, taking into consideration separate and distinct farm operations."

Area Delineation

Area delineation is a type of stratification of risks whereby risks are grouped to account for non-random risk factors such as weather, soil productivity, hail incidence, and growing season. This stratification or grouping involves a priori judgment, which again raises the problems of accurately determining the risk factors and evaluating them. More important, any grouping process works counter to the Laws of Large Numbers--the more grouping or stratification, the less the number in each group. This raises the question: To what limits should the Corporation carry area delineation for rating and coverage purposes? Should there be two, three, four, or ten areas in a county, or just one? Or should there be several counties in each area? What factors should be considered in deciding on the area designations, and how should they be evaluated? Since it is impossible to set lines within and between counties that perfectly take account of risk differences, how can these imperfections best be handled equitably and unequivocably? For instance, within a high risk area there are often low-risk units, especially if the delineation is based primarily on soil productivity. These differences are well-known to the farmers of the area, and often one farm may be located in more than one area.

Many of the county division lines do not follow natural lines such as rivers, mountains or other geological demarcations. Rather, they follow arbitrary survey lines, such as township or section lines. Through the process of setting up a county rate, with area variations, often there is a sharp difference between rates across a county line, not only between farms, but on the same farm, with the same productivity. This leads to misunderstanding between farmers, and between insureds and the FCIC.

A solution to the problem is to re-define the rate areas along natural divisions such as rivers, mountains and other natural and obvious topographical divisions within the state. Figure 16 is a map of Montana indicating suggested major divisions. Minor divisions could be made based on very definite and obvious soil types if necessary. All other differences

Figure 16. Proposed Federal Crop Insurance rate areas in Montana conforming to natural divisions.

would be absorbed in the merit-rating system, principally experience credits, if appropriately reformulated.

Conclusions

Merit rating provides flexibility in an insurance program. The purpose is to take account of effects of non-random differences between insureds and events as they effect individual insureds. Merit rating is not intended to reflect individual differences in loss experience due to "good luck."

Two general types of merit rating are available: A priori or schedule rating and a posteriori or experience rating. Examples of the former are size discounts and judgment rating. Retrospective rating is a combination of schedule and experience rating. Schedule rating has the advantage of prediction within the limits imposed by definition and evaluation of pertinent factors. Experience rating has the advantage of proof of performance.

Two types of rate reductions have been used in the Federal crop insurance program. Experience rating is accomplished with two different formulas in the wheat insurance program, both of which result in inconsistencies together and separately. It is doubtful that present rate credits conform to the purpose of merit rating in either the process of granting credits for good experience, or of removing them for bad experience. Too often they reflect experience due to good or bad luck, rather than non-random differences between insureds. Also, random occurrences, especially area-wide, affect experience credits even though the occurrences are in no way related to the original bases for the credits.

Rate reductions for size have been granted to recognize differences in risk due to dispersion of the insured unit. However, dispersion itself is not a part of the formula except as it is also a function of size.

It is concluded that experience-rating formulas should be revised to accomplish the following:

1. Conform to the purposes of merit rating so that granting of credits for good luck and removal of credits for bad good luck will be minimized.

2. Consistency between insureds and within similar situations, which will thereby improve participation in the program. This should also tend to eliminate adverse selectivity, and most important, improve relations between insureds and between insureds and the FCIC.

3. Eliminate the need for broader and more flexible interpretation of the insurance unit.

It is further concluded that the rate reduction for size should be revised to include dispersion of the unit as a more important factor than size in affecting the incidence of certain factors such as hail. Size, however, remains an important factor as it may reflect better management, equipment, and capital supply.

Finally, it is concluded that area delineations should be revised to conform with natural topographical factors such as mountains, rivers, and surface phenomena, with minor divisions based on abrupt and obvious soil differences if necessary. The residual differences should then be absorbed in the experience-credit formulas.

Retrospective rating should be considered as a method of rating risks which, because of size or other characteristic, fall outside the normal distribution assumed in establishing the base rates. This rating tool will become more important as farms become larger and larger, as discussed in Chapter VIII.

CHAPTER VIII

FEDERAL CROP INSURANCE IN A CHANGING AGRICULTURE

The continued success of the Federal crop insurance program depends upon how well the administration can predict and adjust to changes and trends in agriculture. Since its beginning in 1939, and its major revision in 1947, the program has experienced some of the major changes that have characterized all of agriculture, but is continually faced with new trends and changes. The changes may be classified in various ways, and like all classifications, the categories overlap. The most common subjects discussed relative to agricultural changes are: (1) the average size of farms; (2) technology; (3) prices and agricultural policy; and (4) resource shifts to other industries.

The Average Size of Farms

The growing average size of farms in the United States is the most important adjustment problem for Federal crop insurance, because farm-size growth is accompanied by other changes, such as changes in farm organization, changes in credit demands, changes in attitudes toward other farm programs, and changes in voting strength of the farm population, all overlapping the technological, policy and price changes. Table XXIII shows the trend in the number of farms, land in farms, and average size of farms in the United States from 1900 to 1959. The average size of farms in the United States was relatively constant until after 1935, which corresponds with the beginning of the Federal Crop Insurance Corporation. Figure 17 demonstrates more vividly the upward trend in farm size beginning in the late 1930's, and the sharp acceleration in the 1950's. Relating the changes more specifically to the Northern Great Plains, Tables XXIV and XXV show the changes in farm numbers and size of farms in the Upper Midwest Region and the individual states included therein. A 29-percent increase in size of farm is predicted for the Upper Midwest Region between 1959 and 1975. This would appear to be a conservative projection if the rate of increase continues to accelerate as it appears to in Figure 17 for the whole United States. If farm prices continue to drop and costs

TABLE XXIII. FARMS: NUMBER, ACREAGE, AND AVERAGE SIZE, UNITED STATES CENSUS YEARS, 1900-1959. *

Year	Farms	Land In Farms	Average Size Per Farm
	No.	1,000 Acres	Acres
1900	5,737,372	838,592	146
1910	6,361,502	878,798	138
1920	6,448,343	955,884	148
1925	6,371,640	924,319	145
1930	6,288,648	986,771	157
1935	6,812,350	1,054,515	155
1940	6,096,799	1,060,852	174
1945	6,859,169	1,141,615	195
1950	5,382,162	1,158,566	215
1954	4,782,416	1,158,192	242
1959	3,703,894	1,120,158	302

* Source: U.S.D.A., Agricultural Statistics 1963, page 433, Table 627.

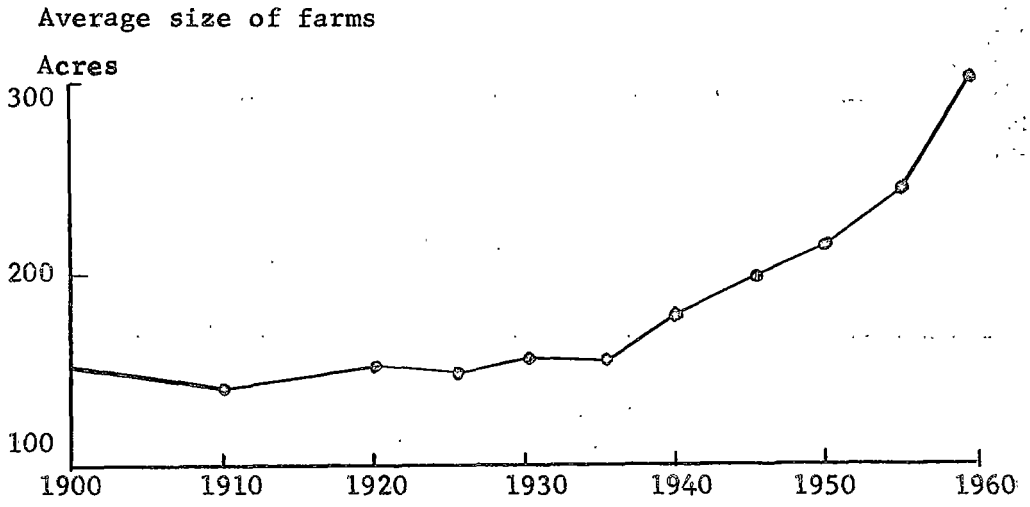

Figure 17. Average size of farms, United States, census years, 1900-1959.

TABLE XXIV. FARM NUMBERS, UPPER MIDWEST REGION, 1949, 1959 AND PROEJCTED 1975. *

Area	1949	1959	1975		
			Number	Percent of 1949	Percent of 1959
	No.	No.			
Upper Midwest Region	418,384	354,509	272,900	65	77
Montana	37,800	34,000	29,500	78	87
North Dakota	66,800	58,000	46,300	69	80
South Dakota	67,500	60,500	49,900	74	82
Minnesota	186,004	158,000	117,900	63	75
NW Wisconsin	49,360	37,800	26,100	53	69
Upper Michigan	10,920	6,209	3,200	29	52

* Source: Upper Midwest Research and Development Council, Upper Midwest Agriculture: Alternatives for the Future, U. of Minn., Minneapolis Dec. 1962, page 64.

TABLE XXV. AVERAGE SIZE OF FARMS, UPPER MIDWEST REGION, 1949, 1959, AND PROJECTED 1975. *

Area	1949	1959	Projected 1975		
			Acres	Percent of 1949	Percent of 1959
	Acres	Acres			
Upper Midwest Region	446	533	690	155	129
Montana	1,564	1,886	2,170	139	115
North Dakota	619	715	890	144	124
South Dakota	661	742	900	136	121
Minnesota	177	195	260	147	133
NW Wisconsin	143	179	260	182	145
Upper Michigan	132	158	310	235	196

* Source: Upper Midwest Research and Development Council, Upper Midwest Agriculture: Alternatives for the Future, U. of Minn., Minneapolis, Dec. 1962, page 63.

continue to rise, forced liquidation of smaller uneconomic units would be a factor tending to accelerate consolidation of units.

What, then, are the ways in which the Federal crop insurance program will be affected by this rapid change in size that is expected during the next 10 years?

The past decrease in farm units has been accompanied by less and more efficient use of labor and increased use of capital. As the use of capital increases, especially with a declining-price situation, an increased credit demand can be expected. An increased credit demand requires stability of income, which in turn should increase the demand for crop insurance.

As farms become larger, it is reasonable to expect increased use of the corporate business structure. The increasing demand for credit for capital expansion also tends to promote the use of the corporation. A corporation places responsibility for resources owned by others in the custody of one or a few individuals. These individuals tend to prefer (if they are made aware of their situation) to convert as many uncertainties as possible into operation costs. Crop insurance is one institution by which this may be accomplished.

Consolidation often involves the transfer and consolidation of estates, which in turn requires incorporation, or the forming of trusts. Here again a few individuals assume the responsibility for others, resulting in another source of increased demand for insurance.

Size as a risk factor is already recognized in size rate discounts. However, it must be recognized that the size discounts will tend to increase, and therefore, if not soundly formulated, will be reflected in adverse changes in loss experience, independent of random perils.

If there is any tendency for the few extra large units within a rate area not to carry crop insurance, this bias in selectivity will be accentuated with the increasing size of units. An increase in the number of extra large farms, for example over 10,000 acres, increases the importance of finding a specially adapted method, such as retrospective rating,

to make insurance attractive to operators of these large farms. In general, it will be vital to the future of the program that adverse selectivity be watched closely as the size of farms increases.

If it is logical to assume that efficiency will increase and uncertainty will decrease with size, then, if the previous risk distribution is continued, the total loss expectancy will decrease. The FCIC should lower rates as units are increased in size, provided the larger units can be retained in the program and if loss expectancy decreases as size increases. One way to encourage larger units to remain in the program is to reduce rates as rapidly as such reductions appear to be justified, being sure that rate reductions for size are soundly formulated.

Technology

Increased size of farms not only increases the demand for more capital, but tends to stimulate innovation, and changes in the kind of capital used. The author has observed the striking shortening of the time required to accomplish certain operations on a farm. For example, the time for completing a harvest on Square Butte Bench in Montana has been cut from over one month to 10 to 14 days on an average size unit, in the past 20 years. This has come about through changes in the quality and design of the equipment, at a cost of tripling the investment in harvest machinery.

Improved technology in the past has decreased the risk from crop perils. The decreased harvesting time greatly diminishes hail risk. Better cultivating equipment has made it possible to store more moisture in summerfallow, by more thorough and timely weed killing. But much more important is the result from spraying growing crops to kill weeds. Just before weed sprays were developed, it was not uncommon for weeds to cut the yields of crops more than half. Without sprays, 25-bushel crops in some of the better wheat areas of Montana in dry years would have been 10-15-bushel

crops 25 years ago. 1/ As technology decreases risks, crop insurance rates should reflect the changes. With continuing research aimed at improving production, there should be little reason to expect anything but a tendency toward decreasing risk, with the exception of outbreaks of unknown perils.

Population growth and shifting demand for farm products result in changing technology. If the shift is toward more intensified farming and high-production crops, investment in crops will increase, affecting the crop insurance demand. New rating structures will need be developed to properly take care of such new situations.

The effects of technology on the crop insurance program are difficult to project. A breakthrough in hybrid wheat development may occur next year, or not for ten years. Based on results in corn, it could raise the average wheat yields as much as 50 percent. If and when it does occur, the whole insurance rate and coverage structure would need to be changed to accommodate it. Likewise, the use of fertilizer still appears to be in its infancy. Any breakthrough in its use could drastically alter grain-crop risks. Though irrigation development has tapered off for the present, should some revolutionary changes occur in irrigation technology, new opportunities would open up for expansion of the crop insurance program, where at present it is in early experimental stages.

Predictions of technological changes therefore indicate a lowering of risk in crop production, but an increasing investment. Continuing research, program flexibility and sound actuarial methods should make it possible for the FCIC to adjust rapidly to these changes.

Prices and Agricultural Policy

Since prices of the principal insured crops are much affected by agricultural policy, price effects can hardly be treated separately from

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1/ Attempts have been made to isolate yield trends due to technological improvements in Montana. However, until some way is found to eliminate the effects of the natural crop factors, results of comparisons are unreliable. Meanwhile this author contends that observations are not to be ignored when so obvious.

agricultural policy, as they affect the crop insurance program. The changes between the 1963 program and the 1964 program are related in two ways to the program of the FCIC: (1) The approximate decrease in support price was as much as 50 cents per bushel, depending upon yield. This has a bearing on the price selection that is available to insureds, in effect raising the ratio between coverage available and the expected crop income. (2) The certificate plan in the 1964 program guarantees a certain level of income to participating farmers, thus accomplishing some of the effect of insurance. The 1965 program combines still another income-guarantee provision to the extent that it allows a farmer to overplant his alloted acreage and the crop produced thereon can be released to be sold during years of poor crops.

These changes in prices and programs have already created some problems that must be met by the FCIC. In his thesis Moore pointed out the situation that now arises whereby a farmer can insure his crop at a price per bushel that is higher than either the market or support prices for wheat. 2/ It is important to analyze how the certificate and price-support program combine with crop insurance under the 1965 program, since this is one of the most important problems of change that now confronts the FCIC.

Some representative situations have been calculated which illustrate the combined effect of FCIC price selctions, market prices, and wheat certificates. The results of the calculations are summarized in Table XXVI. The high-price selection was taken in Area 4 in Chouteau, Area 2 in Yellowstone, and Area 1 in Daniels Counties, representing low- medium- and high-risk areas. A market or loan price of $1.25 per bushel was selected for 1965 and $1.75 per bushel for 1963, representing the approximate 50 cents per bushel differential between the two years. The usual price differential of approximately five to ten cents per bushel between Chouteau

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2/ Moore, Jerry M., Economic Analysis of Crop Insurance in Eastern Colo., M.S. Thesis submitted to Colorado State Univ., Fort Collins, 1964. pp. 72ff.

and Daniels Counties was ignored. The harvest yields were selected to represent a complete crop failure, a medium crop failure, a yield equal to the FCIC harvested coverage, and a yield which would produce approximately the same income per acre as the complete failure in 1965.

Comparing the total return per acre with crop investment levels in Table VIII Chapter V, (Summary of Expenses per Crop Acre for Cash Grain Farms), the following general conclusions can be drawn:

Chouteau County, Area 1 (low risk): The guaranteed income from certificates is more than enough to cover perharvest expenses, but not variable harvest, crop insurance and tax expenses. However, the combination of Federal crop insurance and certificates covers more than total expenses, the excess diminishing as the yield approaches the coverage level. A yield of nearly 25 bushles per acre is required to equal the total of indemnities and certificates paid in the event of a total crop loss. The 1963 situation results in a total return per acre sufficient in every case to cover at least all expenses except land costs.

Yellowstone County, Area 2 (medium risk): The guaranteed income from certificates (based on assumed ASC average yield) is approximately enough to cover total preharvest expenses. The combination of crop insurance and certificates nearly covers total expenses except as the yield approaches the FCIC harvested coverage. A yield of 18 bushels per acre is required to equal the combined returns from a complete crop loss. Converted to the 1963 situation, the total expected returns would have been enough to cover all expenses except family-living and land.

Daniels County, Area 1 (high risk): The certificates alone scarcely cover total preharvest expenses. The combined returns barely cover total expenses except land. Without certificates, in the 1963 situation, returns with crop insurance tend to fall below total expenses except family-living and land.

Note that, in all cases, the minimum return per acre is where the harvested yield is equal to the Federal crop insurance coverage. This will be the result as long as the selected insurance price is in excess of the

TABLE XXVI. COMBINED EFFECTS OF 1965 WHEAT PROGRAM AND FCIC PROGRAM COMPARED WITH 1963 WHEAT PROGRAM, TYPICAL UNIT IN SELECTED COUNTIES.

County	Area	Program Year	1965 ASC Av. Yield	FCIC Harvested Coverage	FCIC Price Selection	Assumed Market Or Loan Price	Harvested Yield a/	Income From Certificates	FCIC Indemnity	Balance of Income From Crop	Total Return Per Acre
			bu.	bu.	dol.	dol.	bu.	dol.	dol.	dol.	dol.
Chouteau	4	1965	30	14.5	2.25	1.25	0	13.28	29.25	0.00	42.53
							6.5	13.28	18.00	8.13	39.41
							14.5	13.28	-----	18.13	31.41
							25.0	13.28	-----	31.25	44.53
		1963		14.5	2.25	1.75	0	-----	29.25	-----	29.25
							6.5	-----	18.00	11.38	29.38
							14.5	-----	-----	25.38	25.38
							25.0	-----	-----	43.75	43.75
Yellowstone	2	1965	25	11.5	2.25	1.25	0	11.07	22.50	-----	33.57
							5.5	11.07	13.50	6.88	31.45
							11.5	11.07	-----	14.38	25.45
							18.0	11.07	-----	22.50	33.57
		1963		11.5	2.25	1.75	0	-----	22.50	-----	22.50
							5.5	-----	13.50	9.63	23.13
							11.5	-----	-----	20.13	20.13
							18.0	-----	-----	31.50	31.50
Daniels	1	1965	20	9.5	2.00	1.25	0	8.85	16.00	-----	24.85
							4.5	8.85	10.00	5.63	24.48
							9.5	8.85	-----	11.88	20.73
							13.0	8.85	-----	16.25	25.10
		1963		9.5	2.00	1.75	0	-----	16.00	-----	16.00
							4.5	-----	10.00	7.88	17.88
							9.5	-----	-----	16.63	16.63
							13.0	-----	-----	22.75	22.75

a/ The yields chosen for each area and year are as follows, in order, downward:
Complete failure.
Medium crop failure.
A yield equal to the FCIC harvested coverage.
A yield which would produce approximately the same income per acre as the complete failure in 1965.

market or loan price. This situation has been developed into a sales device by District Director Money (Wolf Point, Montana) by use of a worksheet which demonstrates how the insured can guarantee himself a minimum income in 1965. A sample of one of these worksheets is shown in Figure 18, worked out for a farm in Richland County, Montana, Area 1.

The conclusion to be drawn from this analysis of the 1965 FCIC program combined with the 1965 price-support program is that price and farm program changes can have a vital effect upon the level of guaranteed protection available to insureds, as related to the various levels of investment in the crop. Under the present FCIC program the price selections available are considerably above market and support prices. However, only in the lower risk areas and at the highest price selections are available insurance coverages greater than the total crop investment.

The emphasis on over-insurance has up to this time been concerned principally with avoiding coverage in excess of the investment in the crop. Until 1964, there was little concern with the problem of insuring for more than what would be the average value of the crop for many insureds. If prices continue to drop, the situation will become more acute. The problem for the FCIC is to determine how serious the danger is and to find ways to adjust to the problem with least disturbance to present insureds, and with a minimum danger of adverse selectivity.

Conflict With Other Farm Programs

The element of guaranteed income provided by the certificate plan under the 1964 and 1965 wheat programs provides a vivid illustration of the danger of conflict between Federal crop insurance and other farm programs. In their comments on Botts' analysis of tying Federal crop insurance to a bushel-quota farm program, Myrick and Larson pointed out the dangers of tying programs together or combining their functions, especially in the case of crop insurance:

> The legislative considerations involved in a marketing program can vary considerably from those involved in an insurance program; thus, such considerations in one program might seriously encumber the economic operations of the other. Legislative changes

Richland County, Area 1

1965 CROP YEAR

I HAVE A FARMING INTEREST - - CAN I GUARANTEE MYSELF A MINIMUM INCOME? ?

The answer to this question is YES - on my 1965 wheat allotment acres.

HOW -----? BY PARTICIPATING IN THE WHEAT PROGRAM AND CARRYING FEDERAL "ALL-RISK" CROP INSURANCE

HERE IS HOW IT WOULD WORK OUT FOR ME -

1. My 1965 ASCS Average yield equals 20 Bu. per acre.
2. My Federal Crop Insurance Minimum harvested coverage is 10.5 Bu. per acre for Area 1.
3. My 1964 Wheat Loan Rate for #3 wheat is $1.17 per Bu.

** (1965 loan rate may be slightly changed, however, it is expected to be about the same as for the 1964 crop year) **

- -

BASED ON ABOVE FIGURES MY MINIMUM INCOME WOULD BE:

Domestic Certificates 20 (Aver. Yield) Bu. x 45% = 9.0 x 75¢ per bu. = $ 6.75

Export Certificates 20 (Aver. Yield) Bu. x 35% = 7.0 x 30¢ per bu. = $ 2.10

My FCIC Minimum Harvested Coverage 10.5 Bu. x 1.17 (Harvested Guarantee #3 Loan Rate) = $ 12.29

TOTAL $ 21.14

Less FCI Premium $ 1.80

TOTAL EXPECTED MINIMUM INCOME ---- (on my share of seeded acreage) $ 19.34 Per Acre

- -

IS THIS A TRUE MINIMUM? Yes, harvesting either more or less than the minimum harvest will increase the income. The only exception would be where No. 4 or No. 5 wheat is produced, due to test weight only, and the total production is within four tenths of a bushel of the harvested guarantee. Even so, then the total minimum would not be more than the 3¢ difference on the loan rate. Usually the protein bonus will more than off set this and your true minimum would still exceed the above computed minimum.

Figure 18. Sample worksheet demonstrating guarantee of minimum income. *

* Source: District Director FCIC Jack Money, Wolf Point, Montana.

> in the agricultural programs could complicate the Federal Crop Insurance Corporation's administration, costs, and actuarial structure to the detriment of the entire crop insurance program. . . .
>
> Another important aspect of the tie-in feature is the possibility that it could eventually lead to elimination of the crop insurance program. A justifiable assumption is that continuance of the program depends upon its "business-like" administration, which includes sound actuarial surveillance, a relatively large, stable participation, large reserves, consistency of premium rates and regulations, randomness of risk, and other attributes necessary to the sound operation of a private insurance company. 3/

Their comments showed how the program's business-like administration could be threatened by independent changes in the other farm programs. The certificate plan is a case in point. It is conceivable that new insureds can turn to the certificates as a guarantee of at least their "out-of-pocket" expenses, and without risking loss of experience credits not yet earned. This would adversely affect participation in the Federal crop insurance program, and create a disturbing effect among insureds in general. Any change made in the price support plan, especially with respect to the certificates, will again add another disturbing influence to the crop insurance program. A continuation of these disturbances to the operations of Federal crop insurance would have a critical effect upon the success of the program.

Attention is called to the history of crop insurance, that it took 17 years, from 1922 to 1939, to enact the Federal Crop Insurance Act, after several unsuccessful attempts of private institutions to provide crop insurance. Another eight years were invested in development and the solving of major problems of administration and rate-making. The past 18 years of experimentation have resulted in sound operations in several important phases of the program, particularly wheat, tobacco and cotton. In Chapter VI it was concluded that a 20-year period was required to

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3/ Myrick, D. H., and Larson, D. K., "Comment on 'Federal Crop Insurance Tied to a Bushel-Quota Farm Program,'" Journal of Farm Economics, Aug., 1963, pp. 665-666.

achieve the effect of randomness over time. The question that will have to be answered by the policy-makers is whether the gains to be obtained from such as the certificate plan in one farm program is worth the risk of jeopardizing the crop insurance program at a time when the country may be on the threshold of capitalizing on the social cost of its development.

If the FCIC must assume that a certificate plan, similar to the 1964 and 1965 program, is to be continued indefinitely, then the corporation is faced with the problem of accepting the insurance feature and to fit its own program into the framework of the certificate and price support plan.

Resource Shifts Within Agriculture

The increasing size of farm units indicates a shift of resources out of agriculture, namely labor. But agriculture has also been experiencing shifts of resources within the industry, with little reason to expect such shifts to cease. One of the most obvious shifts has been the disappearance of commercial farm poultry flocks, an almost complete change toward specialization in the poultry business. Mechanization has been largely responsible for shifting the center of cotton production out of the South toward the West, and Southern Great Plains. The growth of huge cattle-feeder operations in Colorado is an indication of what might be expected in the cattle feeding business. The change in consumer tastes toward leaner beef leads one to ponder the shifts that will eventually occur as a result. The whole problem of satisfying the modern super-market buying structure will definitely result in shifts in the use of farm resources. So far, the changes have been toward more specialization. If the premise is accepted that diversification decreases income uncertainty, and conversely that specialization increases uncertainty, then crop insurance demand should increase as a result. However, as noted before, the program will need to be adjusted to the new type of large specialized units.

Resource shifts within agriculture combined with the enlargement of units considerably increases the need for capital and credit, which will affect the need for crop insurance, depending upon how well the program is adjusted to the changing needs.

If shifts of resources include livestock enterprises being combined with previously specialized crop enterprises, means should be found whereby the crop insurance program can be better adjusted to the livestock-cash-grain setup. There has been a concensus among farmers that livestock adds stability to cash-grain operations. 4/ This is an opportunity for more research, and can form the basis for an adjustment of the crop insurance program to better accommodate the combination enterprise.

As the demand for feed approaches more closely the demand for grain crops as food, it may become necessary for the FCIC to devote more efforts to insuring feed grains in the Great Plains. Reference is made to barley in particular. (Over one-quarter of harvested crop acreage in Montana is barley, whereas barley-insurance contracts number less than one-fifth of the number of wheat contracts.) Another area in which there might be some vital changes is in the production of crops for export. As the level of living rises in developing countries, demands for American crops may increase, especially if the United States can develop crops that specifically meet the foreign demand, and if farmers can become efficient in producing them. Here again the FCIC will need to be alert to new developments.

Conclusions

While it has been repeatedly stressed in this chapter that the FCI program should be alert and readily adjusted to changing conditions in agriculture, adjustments should be guided by two basic insurance considerations.

4/ Thair, P. J., Crop-Yield Risks, Bulletin 392, Agric. Exp. Sta., North Dak. Agric. College, Fargo, June 1954. In a survey of farmers in two North Dakota counties, about 50 percent of them cited safety or security purposes as the main reason for keeping livestock, page 14.

Moore, op. cit., page 46: Farmers who had cancelled their insurance gave first choice to livestock increase as a substitute for the insurance. Starr, G. D., The Federal Crop Insurance Program in Eastern Nebraska, M.S. Thesis presented to U. of Neb., Lincoln, Aug. 1963, page 43. The survey farmers ranked "income stability" second only to "major source of income" as the purpose for livestock on their farms. The livestock-stability premise appears not to have been tested. If it is a questionable premise, then proof of same would have some effect on the participation of livestock-cash-grain operators in the FCI program.

First, a successful insurance program must be projected over a long term of years, sufficient to predict rates based upon a predetermined actuarial base. In Chapter VI it was concluded that the FCI actuarial period should be at least 20 years. Once a projection plan has been established, changes should be considered in relation to the whole long-term plan, not merely on a year-to-year basis.

Second, the success of an insurance program can be seriously jeopardized by continually disturbing the insureds with changes in rates, rules, contracts, and coverage. Continuity of participation is vital to the FCIC program.

A continuous research program by the FCIC would provide the Corporation with information on the effects of changes that are occurring, so that it can better predict and build adjustments into its long-term plans.

Interference with FCI from other farm programs is likely to have a disturbing effect on insureds, in addition to disrupting the long-term plans of the FCIC. The effect is "double barrelled"--the insureds are disturbed on the one hand by changes in the price-support program in which they are participating, and then again by changes that will be forthcoming in insurance coverages and rates. However, the FCIC is faced with the situation that exists, and needs to make adjustments accordingly. Such adjustments have to be made with a minimum of disturbance to the insureds.

CHAPTER IX

THE ADMINISTRATIVE ORGANIZATION OF THE FEDERAL CROP INSURANCE CORPORATION

The Federal Crop insurance Corporation is completely under the jurisdiction and control of the U. S. Department of Agriculture, through the appointment of the Board of Directors:

> The legislation establishes the Corporation as an agency of and within the United States Department of Agriculture and provides for a Board of Directors appointed by the Secretary of Agriculture, composed of the Manager of the Corporation, two other employees of the Department of Agriculture, and two persons experienced in the insurance business who are not otherwise employed by the Government. The Act also authorizes capital for the Corporation intended to serve as a revolving fund and sets up the basis for the insuring of crops. The operating organization was set up as a Corporation so that it might operate somewhat as a private insurance company.
>
> The Secretary of Agriculture is responsible for the administration of the program through the Board of Directors appointed by him, and a Manager. As of July 1959 the two employees of the Department of Agriculture who are on the Board in addition to the Manager are (1) an Assistant Secretary of Agriculture, and (2) the Director of Agricultural Credit Services of the Department of Agriculture. The Board of Directors determines over-all policies and approves the terms and conditions of the insurance contracts offered. 1/

Those who use the services of the Federal Crop Insurance Corporation have no financial interest in the Corporation, nor any vote in its business decisions, in contrast to the semi-governmental corporations such as the farm-credit institutions--the Production Credit Associations and the Federal Land Banks. Also, unlike these other institutions, the administrative costs are born by the Federal government. However, certain parallels are recognized in the Act, and have been revealed by the experience of the FCIC. Note in the above reference that one of the Directors was (and still is) Director of Agricultural Credit Services of the USDA, an indication that there are characteristics of crop insurance that are similar to or

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1/ Federal Crop Insurance Corporation, Federal Crop Insurance, A Description, U.S.D.A., PA-408, Fourth Revision-October 1959, Prepared by William H. Rowe, Federal Crop Insurance Corporation, page 4.

related to credit. Also note that the FCIC was set up as a corporation so that it might operate somewhat as a private insurance company. Finally, note that the Act now requires that the Board include two members who are experienced in the insurance business and who are not otherwise employed by the Government.

The point is that the Federal crop insurance program requires the business-like methods of credit and insurance institutions, dealing with risk and uncertainty, predictions of gains and losses over time, accumulation and dissipation of reserves over time, responsibility as custodian of reserve deposits (investment of reserves), and last, but not least, the development of sales programs and sales personnel, the development of contracts, and the disposition of indemnity claims. The voluntary-sales characteristic of the Federal crop insurance program, especially, sets the program apart from agricultural programs connected with conservation and price control.

Summarizing, the Federal crop insurance program is in no way unlike a private insurance business with respect to setting premium rates so that premiums will cover indemnities over a given period of time; to obtaining a population of participants appropriate to sound actuarial determinants; to selling insurance in competition with other demands for insureds' income; to justly settling claims under contract provisions; to properly managing premium reserves; and to properly managing all the other interrelated problems involved in a good insurance program. The only exception under the present program is that the administrative costs are subsidized by the Federal government.

A Proposal for a Semi-Governmental Organization

There is little in the literature or discussions on crop insurance with respect to converting the FCIC into a semi-governmental (or quasi-public) institution. Nor is it within the scope of this dissertation to dwell on the details of such a change, except as they affect the economic operation of the Corporation. The latter is important enough that it should not be completely overlooked. First, the general features of a

semi-governmental organization should be hypothesized, and second, the merits and demerits should be analyzed.

An independent quasi-public corporation requires the compulsory sale of voting stock to those participants who benefit from the corporation. Therefore this new crop insurance corporation would require that all insureds purchase stock in the corporation when they apply for insurance, according to some given formula for the amount and payment plan. In this way they would become members of the Corporation on a cooperative basis. However, the main portion of the beginning capital would be subscribed by the government, as was the case with the quasi-public farm credit agencies. The initial capital requirements would be for reserves and advance administrative costs. The loss reserves already built up in some crops would become a part of the beginning capital. A crop insurance institution could not be expected to liquidate the original capital, since it does not have the opportunity for "turnover" of the capital, which characterizes lending institutions.

The Government would require representation on the Board of Directors, and would require certain standards of reserves and operational goals as long as it retained a financial responsibility in the corporation.

The proposed corporation would assume the costs of administration of the program, an important change from the present operation. In return, the Federal government would assume an obligation for what would be called "super-abnormal" losses. Examples of such losses are the drouths of 1934 and 1952, and the Florida citrus loss of 1962. Super-abnormal losses would be defined by establishing production norms for regions and crops. When the crop falls below such norm, an emergency appropriation would be made in favor of the corporation, according to a given formula. The corporation would omit such super-abnormal losses in calculating rates. Another idea would be for the government to include in its original capital appropriation a super-abnormal-loss fund, with provisions for annual increases up to a maximum level, the purpose of which would be to accumulate to a level deemed sufficient for the uncertainty of unusual losses.

In summary, the Government would be trading the annual appropriations for administrative costs of the Corporation, for the beginning necessary capital and either annual smaller appropriations to a super-loss fund, or emergency appropriations in case of a super-abnormal loss.

Other proposals might be suggested for accomplishing the same change in the relationships between the Government and the Corporation. Control and ownership by the USDA could be continued as at present, but with the administrative costs being borne by the Corporation, and unusual losses borne by the Government. This would accomplish part of the purpose. Another proposal might be that private companies form a cooperative to take over the Corporation, again with super-abnormal losses to be underwritten by the Government according to a given formula. If feasible, this latter proposal could accomplish the same effects as the quasi-public corporation.

The Merits and Demerits of a Quasi-Public Corporation

The dangers to the crop insurance program arising from discontinuity have been repeatedly inferred and stated in this dissertation. The review of the Congressional Record in Chapter III revealed the problem of political pressure in the expansion of the program. 2/ In the last chapter, it was pointed out that there were also dangers to the program arising out of conflict with other agricultural programs, and that it was necessary for the crop insurance administration to meet the changes that are occurring in the agricultural industry. Above all it should be recognized that

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2/ Typical of political pressure that may be expected as appropriations are considered for the FCIC is the move revealed at the National Association of Mutual Insurance Companies at its annual convention in Denver in October, 1964: That a "Crop Insurance Research Bureau has been formed to 'tell the truth' about the FCIC. A former Pulitzer prize-winning newspaperman by the name of George Thlem of Chicago has been hired to obtain information on the FCIC and its operations. He said that he would 'dig up more facts and figures on FCIC, from the grass roots up,' and 'be able to give some really surprising information about FCIC encroachment into private insurance fields.'" (From the National Underwriter, October 23, 1964.)

crop insurance is similar in essentials to other insurance and consequently should be a separate business enterprise. Finally, the continuation of the Federal crop insurance program depends upon its relative political strength, especially if it must obtain appropriations for administrative costs regularly from the Congress. A side problem here is that appropriations are not always a function of administrative needs: More efficient operations are sometimes rewarded by lower appropriations, rather than increased salaries and funds for needed research; or expanded participation resulting in enlarged administrative efforts may be rewarded by constant appropriations.

In this setting, the proposed change in organization to a quasi-public type is analyzed. With respect to political pressure in expanding and developing the program, two problems could be alleviated. First, the conflict coming through changes in other farm programs could at least be separated, and direct pressure be eliminated. Second, and more important, the pressure resulting from regular administrative appropriations could be lessened if these could be converted to smaller or much less frequent appropriations, such as occasioned under the proposed reorganization.

It has been pointed out that the other farm programs, particularly in wheat, are undermining the crop insurance program by providing some elements of guaranteed income by certificate and storage plans. Such undermining would be particularly crucial to an independent corporation. However, it would appear that the USDA would be obligated to protect the interests of the insureds, which interests would be more vital if they involved an actual ownership of the Corporation. Under the present organization, where the insureds do not even own the reserves, the program can be discontinued with consideration only for the obligation concerning outstanding insurance contracts. In any case, a continuation of a sound crop insurance program under any type of organization requires that its functions not be usurped or altered by changes in other programs. Sound actuarial methods can be developed only over a long span of years, a difficult enough job without special hurdles being thrown in by changes in other governmental policies.

Changes in the agricultural industry are placing new demands upon the crop insurance program, such as adjusting to larger units, improved technology, increasing credit demands, and changing farm organization. To the extent that an independent corporation could operate in a more business-like manner, and could become more flexible in its operations, and devote more effort to research, it could meet the industry changes more efficiently.

If the administrative costs were to be absorbed by the FCIC, the problem would be whether or not the premium level would be raised to the point of appreciably hindering participation in the program. If administrative costs amount to about 25 percent of the premium income of the Corporation, they would become 20 percent of the premium income if absorbed by the Corporation. This premium increase for administrative costs would then need to be compared with how much the premiums could be decreased if the super-abnormal-loss risk is removed from the present premium level. It is assumed that the actuarial formulas include some weighting for such a loss risk.

One problem the proposed reorganized Corporation would need to face is the cost of experimentation. As long as the program is being expanded into new crops and into new areas, the government would be required to share in whatever losses occur due to insufficient knowledge before the program is well established. Also the research required to expand into these new areas should be a cost borne by the public rather than by the Corporation.

In conclusion it should again be emphasized that the Federal Crop Insurance Corporation is a business more akin to a private insurance company, or to the quasi-public agricultural credit institutions, than it is to the price-support and stabilization programs of the Department of Agriculture. For this reason there is merit to giving consideration to reorganizing the FCIC more along the lines of these institutions, with a goal to removing it as much as possible from short-term political pressures and interference from frequent changes in other agricultural programs.

CHAPTER X

SUMMARY AND CONCLUSIONS

The purpose of this study is to contribute, along with other contemporary studies in the Great Plains, to finding answers to the question: "What variations in the Federal all-risk crop insurance program would increase its effectiveness and acceptability as a program and make it more nearly meet the needs of the farmers?"

Perfect insurance, according to the formal definition, has certain requirements, and the closer an insurance program can adhere to these requirements, the sounder will the program be: (1) Statistical predictability, requiring randomness and independence of occurrence of events; (2) losses accidental--no moral hazard; (3) determinability and measurability of losses; (4) losses not subject to catastrophe perils; (5) losses which are significant to the potential insureds; and (6) relatively low probability of loss. No insurance program is able to meet all these qualifications. But they serve as a guide to seeking out the problems which are to be solved in improving the efficiency of a program such as Federal crop insurance. Most of the problems arise out of the deviations from the ideal situation.

Insurance is only one of the alternatives available to farmers in solving the economic problems arising out of uncertainty in crop production. The farmer is in the position where he must weigh the advantages and disadvantages of the various altenatives and make a choice. Insurance has the advantage of converting the possibility of a large, uncertain loss into a small certain cost. It shifts risk to firms which specialize in risk assumption. It releases resources which might otherwise be frozen as reserves against uncertainty. It provides protection agains the loss of solvency for the individual who has had no opportunity to build resource reserves or devise other methods of providing for financial risk. These advantages of crop insurance will be weighed by the farmer against the alternatives available to him.

Federal all-risk crop insurance is fundamentally no different from other types of insurance, private or public, to the extent that premiums

must be based upon expected losses arising out of perils insured against, depending upon the coverage level. Whereas most insurance is based on events happening randomly over a relatively short period, usually a year, all-risk crop insurance is based on events happening randomly over a much longer period, as much as 20 years or more. This results in two unique problems: (1) The actuarial period for rate-making must be of long duration, at least 20 years; and (2) the length of the period, along with the potential for a wide geographic distribution of a loss in one year, requires an availability of resources that can be furnished or underwritten only by the Federal government. The important point to be emphasized here is that, once launched, the Federal crop insurance program must be considered uniquely different from other agricultural programs, if it is to be operated on a sound insurance basis. It cannot be appreciably changed frequently, as other farm programs, and changes that affect its actuarial base, such as development of competing farm programs, can seriously affect the success of the operations in accomplishing its objectives.

Like other insurance, Federal crop insurance must be sold. It is in competition with other choices available to a buyer as he spends his income. At this point it is assumed that the benefits from crop insurance are worth the social cost involved in paying the administrative costs. High participation is necessary if it is to perform its objectives efficiently. Although some farmers readily purchased the insurance as it became available, and others knew they needed it, a sufficient number would not voluntarily purchase it without being informed of what it could do for them and of its cost. This argument was not accepted in the first phase of the program, but was later accepted as essential to its successful operation.

Federal crop insurance shares with other types of insurance the problem of imperfections in randomness, lack of independence between events, possibility of catastrophe, and insufficiencies in other perfect-insurance requirements. Federal crop insurance strives for high participation as the best protection against adverse selectivity of risks. The number of

insureds relative to the total annual insured liability is low and extremely variable. The influence of management on the probability of loss is relatively high, especially at the critical level of yield, where insurance becomes effective. Like other insurance firms, the FCIC is obligated to cope with these problems of imperfection.

The expressed purpose of Federal crop insurance was to protect the farmer's investment in his crop, to keep him in business through periods of heavy crop loss from natural perils beyond his control, and to improve his ability to obtain credit in years of crop loss. The FCIC from the start was charged with the responsibility of collecting sufficient premium to cover the losses. It was also forced into unrestricted insuring of crops for which very little if any actuarial data had been accumulated. Its loss experiences were scrutinized and judged essentially on an annual basis. The resulting high-loss experience during its first few years of existence led to its suspension in 1943. In 1945 the program was reinstated, and in 1947 was established on an experimental basis upon which it has since operated. The FCIC now has the essential characteristics of a modern insurance corporation, involving experienced insurance personnel on its administrative staff, trained actuaries in its rate-making division, machine computing and accounting, an up-to-date sales and product-development staff, and a research program. Its loss record indicates a sound operation. Participation, based on percentage of insurable units, is increasing, and the administative cost, as a percentage of premiums, has remained relatively low, indicating increased efficiency.

A study of production costs in three different cash-grain areas of Montana indicates that in some cases, mainly in the lower-risk area, the available coverage has been sufficient to cover total investment in a crop. In the Northeastern area of Montana, the available coverage has not been sufficient to cover total cost, in most cases covering only the costs other than family living and interest on investment in land. The degree to which the available coverage meets the investment in the crop varies considerably about the state from area to area.

Drouth is responsible for almost two-thirds of the indemnities paid by the FCIC from 1947 to 1963. Precipitation records are therefore pertinent to the length of the actuarial period and randomness of loss occurrence over time. The records in the Great Plains indicate that there were two complete weather cycles in the past 42 years, each of approximately 20 years duration. This indicates that an actuarial period must be of at least 20 years duration; i.e. an insurance premium established on wheat in a particular area in 1947 should not be expected to produce a loss ratio of 1.00 until at least 1967. Further, the records indicate that the frequency of four or more consecutive years below normal precipitation in the Great Plains averaged more than two for each station examined, during the 42-year period. Recalling that average precipitation in the Great Plains is near the critical level for crop production, the frequency of consecutive years of unfavorable loss ratios is evident.

Merit rating in insurance encompasses the adjustments of premiums to take account of the effects of non-random differences between insureds and events as they affect individual loss expectancies. Two types have been used by the FCIC: (1) Discounting the premium according to the size of the insured unit, based on the assumption that size or dispersion of the unit decreases the insured loss expectancy. (2) Allowing a discount for favorable loss experience, based on the assumption that non-random acts of insureds decrease loss expectancy, and can be accounted for by experience credits. Both methods in present use appear to develop inconsistencies and do not conform to the theoretical purpose of merit rating to the extent that they might under a revised formulation. Too often experience credits reflect favorable experience due to <u>good luck</u> rather than to non-random differences between insureds. Also, the absence of experience <u>debits</u> has the effect of applying a surcharge to the new insured entering the program, rather than charging him a premium based on the average. Likewise, the size discount, while based at least partially on the assumption of dispersion effect, takes no account of dispersion except as it is reflected in size.

Changes that are rapidly taking place in agriculture present problems of adjustment in the Federal crop insurance program. The increasing shift from labor to capital may tend to increase the demand for crop insurance, along with the influence of more incorporated farms and contract management. If the FCIC is to guard against adverse selectivity it will need to adjust to the increasing number of exceptionally large units. The total number of units will continue to decline, and the number of large units with special insurance problems will increase, though the net effect is toward a smaller insured population. Continued improvements in technology not only increases the demand for capital, but also will affect yield, and therefore the risk and the loss expectancies of individual farmers.

A change in agricultural policy imposed a very important problem upon the FCIC when the certificate plan was instituted for the 1964 wheat crop. In essence it provided a partial function of crop insurance, guaranteeing a certain level of income, regardless of the crop yield. The program is continued in 1965, and Secretary Freeman has revealed an interest in an increased use of the certificate plan for the 1966 crop. The certificates can be expected to have an influence upon participation in the insurance program. The FCIC is faced with adjusting to the effects of the certificate plan, whatever these effects might be, as they are revealed in selectivity, over-insurance, etc. With the advent of a conflicting agricultural program, a new non-random risk has been added.

The FCIC is a corporation completely owned and managed by the Federal government, which pays all the administrative costs and appoints the manager. The FCI Act provides (under Section 508) that the FCIC can reinsure other insurers of producers of approved crops under approved plans. No company to the time of this writing has availed itself of this provision. It is conceivable that the FCIC will be required to assume the administrative costs and also to convert to a quasi-government corporation, similar to the Farm Credit institutions. The nature of the FCIC operation is more akin to credit institutions than to price and income programs of the USDA. It sells a service for which it collects a payment directly

from those receiving the service. Aside from administrative costs, it is obligated to be self-supporting. Administrative pressures on budget-trimming may lead to organizational changes of the nature described.

Conclusions

The unique nature of crop insurance as a business should be clearly understood by policy-makers and farmers. Because of the nature of perils insured, its success and service cannot be judged in the short run. The actuarial term upon which premiums are based must be at least 20 years. Like all insurance a long period of experiment and adjustment is necessary for development of sound methods, and correcting problems that develop in the experimental period. After the experimental period, a successful insurance venture must continue to utilize its experience in adjusting to the continually changing economic conditions.

Farmers and policy-makers should be aware of the fact that it took 16 years of congressional debate to bring the program into being. After its birth, 8 years were invested in development and venturing into new areas. The program was then placed on an experimental basis, where it has been operating for the past 17 years. The total social cost (governmental appropriations and net excess of indemnities over premiums) has been nearly $200,000,000. It is concluded that this investment of public funds, the accumulation of experience, the training of personnel, and the record of successful operation in the past 17 years all adds up to a resource that should be considered with respect as policy is formulated, and as farmers appraise institutions that are of service to them. A specific example is the certificate provision of the present price-support program.

The influence of trained insurance personnel and the development of a modern insurance-sales program has undoubtedly been one of the most effective factors in the successful operation of the FCI program. It is concluded that there is much more that can be accomplished in developing the problem-solving ability of the sales force. A better understanding of the nature of farmers' decision-making processes, and of decision theory should contribute to expansion in participation in the insurance program.

This appears to be one of the areas of research that shows the most promise for improving the crop insurance program. One suggestion is that a more intensive survey be made of farmers who have been in the program since its inception, or at least since 1947. A supplemental study would be a similar intensive survey of farmers who have never been in the program. The result should be a much deeper insight into farmers' decision-making processes. Fringe benefits would be information on experience credits, unit division, size credits, and other devices for improving the program.

The original objective of the FCI program was to cover the farmer's investment in the crop. There should be more attention given to setting coverage levels according to average costs of production, with premiums becoming the variable factor of the relationship.

Merit rating (experience, dispersion credits, etc.) shows promise of solving some crop insurance problems if used more extensively, and according to the theoretical purpose of merit rating. Merit rating should be formulated to account for as many individual non-random differences as possible. It should encourage practices that decrease the individual's loss expectation. If it is not desirable to rate the new insured above the average loss expectancy, then rate debits as well as credits should be applied. It is concluded that under these criteria, merit rating can be used to help solve the following problems:

Rate areas have been established on the basis of county lines, and natural phenomena within counties. The small areas result in a relatively small number of insureds in a rate group, which is adverse to good insurance principles. Because farms are increasing in size, the number of insureds will continue to decrease. Also, dividing on county lines results in different rates between insureds on almost identical land, and even within units. It appears advisable that rate areas should be segregated on pronounced natural boundaries, such as rivers, mountain ranges, and sharp soil and topographic variations. This would tend to result in much larger rate areas, with possibly more individual differences in risk than

now exists. The hypothesis is that merit rating can be used more extensively, then, to take sufficient account of these differnces.

The definition of an insured unit has been broadened to allow much more extensive division of units under one farm operation. This has caused considerable difficulty in administration because of the problem of establishing consistent rules, and policing the established rules. Part of the reason for liberalizing the definition of units is based on the idea that dispersion decreases risk. (Farmers are already realizing that if they divide their operation into more units, their probability of building experience credits is less.) If the size-credit formula were revised to take account of dispersion as well as size, the unit definition could again be based on factors which are unequivocal, such as ownership, or being in a different rate area.

There appear to be inconsistencies between insureds and between different areas as to their experience credits. It would appear that more consideration could be given to the theory that rate discounts should avoid as much as possible increasing or decreasing experience credits due to random occurrence, or good or bad luck. The merit-rating formula should therefore, in some way, take account of the over-all area experience as it applies to an individual's experience record; likewise it should in some way take account of unusual catastrophic situations that under the present formula cause an individual to lose an experience rating.

Finally, disturbance of insureds should be avoided as much as possible. This appears to be in conflict with conclusions to the effect that the FCIC must be continually adjusting to change, and that rating formulas and rating areas should be changed. The point is that changes should be made, but should be applied only after extremely careful deliberation, and applied with as little disturbing effect as possible. For example, if the experience credit formulas were revised, the new formula could be applied to new insureds and those who have not yet earned a credit. Changes in rate-area boundaries could be made in such a way that rate changes would not be too drastic in any one year.

One type of disturbance that tends to cause difficulty is that associated with the almost-annual change in the agricultural price programs. This not only eventually disturbs farmers in general, but is also disturbing to the crop insurance program itself. Again, the most recent example is the certificate and storage phases of the 1965 wheat crop program.

The final conclusion is that commendable progress has been made in the Federal all-risk crop insurance program, and that there are ways that it can be improved to better serve more farmers, and even to the point of becoming a self-supporting business. It is doubtful that either of these goals can be achieved unless a decision is reached with respect to conflict between the different government programs.

APPENDICES

APPENDIX A

ENDEAVORS OF PRIVATE COMPANIES

Chapter I, from Buckler, James L., All Risk Crop Insurance, A thesis submitted to George Washington University, Federal Crop Insurance Corp., U.S. Department of Agriculture, December 1950.

Insurance is a natural undertaking for private business concerns since insurance and business have gone hand in hand from the time marine insurance was first introduced in Italy in the twelfth century. The sharing of risk through insurance has become such an integrated part of business operations that today there are very few concerns without such protection. As farming became more businesslike in operations, with the farmer growing crops to sell and in turn buying manufactured products, the need for farm insurance protection was felt.

Specific risk insurance, such as hail and fire, have been available to the farmer for approximately seventy years. In addition the farmer has been able to obtain protection against the destruction of his equipment, his house, and, through life insurance, the loss of services. However, the real need has been for a comprehensive risk protection against the natural hazards inherent in pursuing his livelihood--that of growing crops.

General crop insurance presents two great differences that make the writing of it a riskier undertaking than the already established types of insurance. These two elements are the unpredictability of nature and price fluctuation. It is possible for an insurance company in this field to operate successfully for a few years and then to have a severely damaged crop or a drastic drop in price that would wipe out all profits and capital. In spite of these risks the need for such insurance has been so great, and the desire for it so strongly expressed, that several companies in the last fifty years have tried to write all-risk insurance. Unfortunately, each company closed after a short period of operations.

Operating Experience of Private Companies

The Realty Revenue Guaranty Company (1899).--The first known undertaking of general crop insurance by a private company was in 1899. The Realty Revenue Guaranty Company of Minneapolis, Minnesota, offered one of the simplest insurance contracts ever presented to farmers. This contract, covering both natural and price hazards, guaranteed the farmer an income of five dollars per acre in return for a premium of twenty-five cents. The contract contained an optional clause whereby the insured could offer and the company would have to accept the production of the insured's farm at the agreed contract price of five dollars per acre. This meant that the company would not only insure against all natural hazards, but also insure against price risks. For example: if wheat was selling for one dollar per bushel, it would become profitable to the insured to exercise his option if production fell below five bushels per acre. Little was

known about the internal operations of this company except that in the court case of the State of North Dakota vs. Hogan, 8 North Dakota 301, it was indicated that the management was inefficient. The company also accepted notes from the farmer in payment of his premium with the stipulation that these notes were to be liquidated at the harvest of his crop. The company discounted the notes, closed operations, and left the farmer with no alternative but to pay the holders of the discounted notes without being able to receive indemnities if he had lost his crop.

Bankers of Montana and the National Union of Pittsburg (1917).--The next attempt by private companies came in 1917. Bankers of Montana and the National Union of Pittsburg sold similar policies in the spring wheat area. These policies insured wheat, flax, rye, oats, barley, and speltz against all risks except fire, flood, winterkill, and the failure of the farmer to follow good farming practices. A premium of seventy cents was charged with a guaranteed seven dollars per acre in the case of a total loss. Partial failures were indemnified by the difference between the value of the partial harvest and the face of the policy. The value of the partial harvest was computed on a predetermined fixed price basis. This policy was designed to cover yield rather than price. Both companies suffered heavy losses--about two hundred thousand dollars by Bankers and over a million dollars in the National Union. In addition to the severe drought that occurred in the insured areas, it has been brought out that the failure was due to (1) poor management by the officials; (2) the capital of the company, fifty thousand dollars, was too small for such an undertaking; (3) the risks were highly concentrated rather than being spread out; and (4) that the insurance was written too late in the year. There was much evidence that a large part of the business was written after it was well known in the farming area that a crop loss was apparent. The method of handling insurance by this company was described as follows: 1/

> The local agents for the insurance company were officers of the different local banks throughout the territory. Almost all of the farmers were indebted to these banks with the idea that the debt would be paid from the proceeds of the coming crop. Just as soon, therefore, as it became certain that drought was going to ruin the crop, the banks were faced with a situation out of where there would be no money coming to them. Immediately there was a flood of applications for insurance, and the insurance was gladly written by the bank.

A large volume of the losses were repudiated and in some cases fraud on the part of the insured was claimed. Many claims against the National Union were settled by the return of the premium only to be contested later

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1/ G. Wright Hoffman, "Crop Insurance--Its Recent Accomplishments and Its Possibilities," The Annals of the American Academy of Political and Social Science, CXVII (January 1925), 101-102.

when it was determined that the company could settle in full.

The Hartford Insurance Company (1919).--The Hartford Fire Insurance Company made the next attempt at writing all-risk insurance. Beginning in the fall of 1919 this company introduced a new type of policy on a national basis. This policy is known as the investment type, covering the cost of production, and in some cases ground rent for the crop year 1920. A premium averaging five and three-fourths percent was charged for the contract which protected the farmer against loss or damage to his crop--"when caused by the elements including frost, winterkill, flood, drought, insects, or disease, but excluding loss or damage when caused by fire, hail, wind, or tornado, or failure of the seed to germinate, or failure of insured to properly prepare the ground for seeding, or to properly seed, cultivate, and harvest said crops." The company collected approximately eight hundred thousand dollars in premiums on an insurance liability of about fourteen million dollars; losses were prevalent throughout the country and totaled over two million five hundred thousand dollars. The recession of 1920 with its drop in the price of grain contributed materially to the company's losses. Another difficulty with the policy was that the coverage was based on the farmer's estimate of his cost. No two farmers agreed on what it cost them to produce a crop. Because of heavy losses in 1920, the company revised its policy for 1921 in an effort to eliminate the risk inherent in price fluctuation. The new policy, which guaranteed a yield per acre, carried the following provisions:

1. If the value of the crop at harvest equaled the coverage in the policy or the cost of production, there was no indemnity.

2. If the production equaled the insured protection, regardless of the price received for the production, there was no indemnity.

For example: if the insured protection was eight bushels to an acre, and the farmer harvested five bushels, and the market value of that five bushels equaled his cost of production, there would be no indemnity. On the other hand, if the production were ten bushels, or two above the insurance coverage, there would be no indemnity even though the market price of the ten bushels did not equal the cost of production. This new provision in the contract was not appealing to the farmers, and business fell off materially in 1921. The company ceased its national operations after 1923.

The Home Insurance Company of New York offered a contract similar to the Hartford Company in 1920 and 1921 with equally unsuccessful operations.

Agricultural Protective Mutual Insurance Company (1931).--The next effort of private business in the all-risk insurance field was in 1931. A Kansas Company, the Agricultural Protective Mutual Insurance Company, offered in the years 1931 and 1932 a cost of production policy that carried a maximum risk coverage of two thousand dollars. Premiums on this policy ranged from five to thirteen percent of the coverage. Like some of its predecessors, this company also insured both price and yield.

Danger of a price insurance contract was again forcefully demonstrated when the price of wheat declined rapidly in 1931 and 1932. Heavy losses followed the price declines and the company had to cease operations. A study after the failure of the company upheld the contention of the manager that the cause of loss was one of price. The company would have made a profit if the price of wheat had remained at fifty cents or above.

Sowers Plan of Insurance (1937).--The last attempt by a private company is known as the Sowers Plan of Insurance. This company also operated in Kansas, and issued a policy in 1937 and 1938 similar to that of the Agricultural Protective Mutual Insurance Company. In order to overcome to some extent the risk of price fluctuations, the company provided a minimum price to be used in computing production income. Unfortunately prices of wheat fell to the minimum level and forced the company into bankruptcy.

Since the bankruptcy of the Sowers Plan, no private company has attempted all-risk crop insurance. They have been content to watch the experience of the Federal Government in this field before again risking their capital. The present charter of the Federal Corporation provides for reinsuring any private company wishing to undertake all-risk insurance. Although several companies have expressed an interest in this provision, none have been willing to write insurance and issue policies covering risks and offering benefits similar to the policies issued by the Federal Corporation.

Causes of Failure

Why did private companies fail in their effort to write general crop insurance? Causes of failure based upon review of the operations of these companies could be summarized as follows:

1. The type of insurance offered covered more of a price risk than a production risk. Successful crop insurance should offer protection to the farmer from the natural hazards over which he has no control without injecting the moral risks involved in price fluctuation. A combination yield and price insurance was a losing proposition. Poor crop years resulted in indemnity payments because of lowered yields, and bumper crop years dropped commodity prices below the insured level. (It should be noted that this refers to the period before price support programs, which in effect is price insurance without premiums for farmers producing a crop.)

2. The companies had entirely insufficient data on which to base rates and coverages. The rates were too low for the risk involved or the coverage was too high as a result of being based on cost estimates furnished by the insured rather than long range actuarial data developed by the companies.

3. Adverse selectivity was a major weakness. Such weakness was reflected in the high concentration of the insurance risks and in the late dates used for accepting applications. In many instances applications were accepted after it was evident that a crop could not be harvested.

4. Another of the major contributions to the failure of the companies was poor management and inexperienced insurance workers. Both the management and workers were not familiar enough with agricultural operations to cope with the uncertainties and individual farm variances found in agriculture.

5. The final was inadequate capital to withstand a severe initial loss. Sufficient capital would have given the companies the advantage of longer periods of operation. Most companies apparently gambled on the hope of making profits before having poor crop years. There happens to be an unusually unique relationship between the years of operation and the weather and economic conditions. Invariably each of these companies was faced at the outset with either a severely poor crop year or a year of rapid price declines that increased losses materially.

APPENDIX B

FARM RISK INSURANCE

Extension of Remarks of
Hon. Edward J. King, of Illinois
In the House of Representatives, Friday, March 3, 1922.

Mr. King. Mr. Speaker, one of the most important questions before the farmer today is that of crop insurance, and in this connection I desire to discuss H.R. 10294, a bill authorizing the establishment of a bureau of farm risk insurance in the Treasury Department.

This bill was introduced by me with the indorsement of various farmers' organizations, financial leaders, and students of farm economics, and is now before the Committee on Agriculture of the House.

The bill provides for the establishment of the bureau, allows a director at $5,000 per year, and states that the bureau shall, as soon as practicable, make provision for the insurance by the United States of growing crops of nonperishable products against loss or damage by the action of the elements.

An advisory board of three insurance experts, to be paid not to exceed $25 per day while actually working, is provided to aid the director and the Secretary of the Treasury in publishing a standard form of farm risk policy and to fix reasonable rates of premiums.

Losses would be paid promptly, and in case of disagreement as to claims the claimant would have the right to take the case into any United States district court. A revolving fund of $10,000,000 to inaugurate the system is provided, as well as $100,000 to cover the expenses of the bureau during its initial year of operation.

However, the bureau would be self-supporting in entirety, premiums being determined according to cost. Farmers would be charged the actual expense of carrying their risks, although I would oppose any tendency by the bureau to earn a profit.

Mr. Speaker, agriculture is the only industry that can not obtain insurance, and in view of the great hazard surrounding farming, the primary interest of the Nation in making certain that its people have sufficient to eat, and the discouraging, if not fatal, conditions surrounding food productions today, I most earnestly urge favorable consideration of this bill.

This bill, with its resultant effect in stabilizing food production, is just as important to the dweller in New York as it is to the farmer. It means as much to you Members of the House from Chicago or New York as to the man from Iowa.

Bankers who have loaned the limit to food producers in their vicinity will be encouraged by knowing that they will be certain of repayment. Crop insurance would enable the farmer to obtain cost of production back,

keep him on his feet, and carry him over disastrous places.

Where today farmers in many cases can not borrow money for seed because of the lack of security, under this bill they could be accommodated by their bankers. The farmer could assign the insurance policy to the bank as security. The banker's risk would be eliminated.

The maintenance of the bureau of farm risk insurance would not cost the Government a cent. Why? Because it would be self-supporting through the premiums received from policies sold. The premiums charged for the insurance would be sufficient to pay all expenses of the system.

Theo. H. Price, editor of Commerce and Finance, and one of the enthusiastic proponents of crop insurance, wrote a very able article on the subject in his paper of January 25. This article was placed in the Record by Senator Sheppard, of Texas, who is today urging an impartial investigation of the subject, and is very interesting.

Mr. V. N. Valgren, associate agricultural economist of the Department of Agriculture, who has studied the subject of crop insurance for many years and is the author of several brochures and articles on the same, states as follows:

"1. The insurance must cover only such crop damage as will result in serious financial loss to the farmer. This means that only a reasonable amount of insurance an acre must be written. For establishing such reasonable amount the average yield and price for a series of past years is perhaps the best basis. It means, furthermore, that the acreage of a given crop, if not the entire farm, must be insured as a unit and adjustment made on the basis of average yield of such acreage. The total loss of a crop on one or a few acres out of a hundred is not a serious loss if the acreage as a whole gives average returns or a substantial part of such acreage.

2. The insurance must cover any and all hazards which are beyond the farmer's control. Insurance which protects against certain hazards and leaves the insured exposed to total loss from other hazards beyond his control is not real crop insurance.

3. In no case must the insurance protect against loss from carelessness or negligence on the part of the insured. Such protection would involve a moral hazard, the encouragement of which is against the best interest not only of the company but also of the insured and of public welfare in general.

4. The premium, or cost of insurance, must bear a reasonable relationship to the value of the protection that it purchases. This means that the expense item in the expenditures of the insurance organization must be held to a

minor part of the premiums collected; that profits, if the organization operates for profit, must be moderate; and that the bulk of the premiums must be available for the payment of current losses and in favorable years for additions to a reserve for the payment of future losses.

5. The method of adjusting loss must be such that the insured will receive indemnity for crop damage in the amount or on the basis that he is led to expect from the figures indicating the amount of insurance an acre. The company should not profit by a calamity to the farmer in the form of reduced prices for his product.

6. An early adjustment should be provided for in case of total failure of an insured crop, or such an approximation to failure that it would not pay to mature and harvest the crop. The part of the income or yield guaranteed by the contract, which becomes due under such circumstances, should be plainly stated and should not exceed the value of the labor and other costs, including rental, that are actually lost to the insured in connection with the crop.

7. All adjustments involving only partial damage should, so far as possible, be left until after the crop has been harvested and put into marketable form, so that quantity and grade can be determined. This makes possible economy in adjustment expense.

8. Lastly, there must be a certain degree of understanding between the farmers and the company or agency offering the insurance if protection is to be available on truly favorable terms. Crop insurance must be bought on the same principle as fire insurance is purchased, merely as a guaranty against serious loss and not with the expectation of securing an indemnity every two or three years. If the insurance is to be written with the idea that frequent indemnities for minor cases of crop damage are to be paid, it necessarily becomes so expensive that those in greatest need of it can ill afford to buy it. The insured should find some method of helping the organization providing protection to reduce the heavy expense connected with the acquisition of business which now prevails in nearly all lines of insurance, at any rate where the business is conducted on a commercial basis. In some of the European countries farmers' organizations have applied the principle of collective purchasing to their insurance problems. Perhaps the farmers' organizations of the United States will find some way of solving this problem on a plan consistent with American laws and American conditions."

Practical Experience

Mr. R. M. Bissell, president of the Hartford Fire Insurance Co., a company which has had experience in this field, gives valuable information in a letter to Congressman E. Hart Fenn, as follows:

> "As regards crop insurance, we do write crop insurance, but having had our fingers severely burned in experimenting with this form of insurance, we are now proceeding in a far more careful fashion. The problem of writing insurance on the major crops, such as corn, wheat, rye, oats, and cotton, is a tremendous one, and full of the most puzzling intricacies and problems, which were unsuspected when we undertook it. After nearly three years of experimentation, during which time we have lost a very large sum of money, we have finally come to the conclusion that insurance on the large crops can only be undertaken on what might be called a banking basis; that is to say, the amount of insurance must be limited to what a bank would under ordinary circumstances advance to the farmer to enable him to finance the making of a crop including harvesting. Farmers, as a matter of fact, have very little exact knowledge about many matters having to do with crop production, especially the matter of costs and average yields, and any attempt to insure farmers on a basis of the full cost of production or guaranteeing an average price for an average amount of production in bushels would involve possible losses which would run into the hundred millions, and very probably into the billions, for a single year.
>
> We are hoping to very shortly work out a plan with a syndicate of companies whereby we can afford to take on insurance on the larger crops. In the meantime we are doing quite a little business on special crops in connection with truck farms, fruit orchards, canning factories, etc."

A bureau of crop insurance started two years ago would have eliminated much of the present agricultural destitution, according to Mr. N. C. Sanford, cashier of the First State Bank of Celina, Tex. He continues:

> "In this connection let me state that I am pleased to go on record as unreservedly indorsing this move, which is and can not help being very far-reaching in its effect and influence upon the economic life of the United States. In legislation such as this I can not but feel that here will be found a panacea for the ills that financially beset the farming populations and communities of the world.
>
> From the above statements, which, I will admit, may sound somewhat radical, one might be led to believe that the author of them was inclined to socialism. Indeed, this is true if by that term we mean the greatest good for the greatest number of people. However, if it is not socialism to

subsidize other industries and businesses; if it is not socialism to erect protective tariffs around these industries and classes, then, the argument that legislation to favor crop insurance would make farming a favored industry does not seem to me to be pertinent.

The fact that you have seen fit to introduce such a bill as you have is sufficient evidence that you see the ultimate possibilities in the project. Whether or not it is incumbent upon the Federal Government to undertake this responsibility is the question involved. I am sure no right-thinking man in any line of industry will advance the theory that the farmer does not need some kind of assistance. It is no secret that the farming industry as a whole is in very straightened circumstances, if you will permit that expression. From some of the suggested legislation brought forth at the late meeting of farmers' representatives held in Washington one may easily gather the impression that the farmers are fighting in the last ditch and with their backs to the wall. And from first-hand information gathered from living in a farming community, and from daily contact with farmers who till the soil, who come to me offering and almost begging to mortgage anything they possess now or hope to possess in the future, for enough money to keep themselves and their families alive, one is likely to come to believe that the farming industry in this community is indeed 'up against it'. And what is true of this community is also true of others. We are fortunate in that we think we are somewhat better off than most places.

If there had been an insurance bureau operating in the past two years, we would not now be practically destitute nor would our condition be alarming. It is to prevent a recurrence of such calamities as have befallen us in the past that we ask for an investigation into the possibilities or feasibility of crop insurance. As a guaranty that the farmer is in earnest and has determined with an unbreakable will and a fortitude that is deserving of the highest esteem to overcome and surmount the difficulties in which he finds himself, one has only to investigate the conditions of the farms as they now are preparatory to making another crop.

I am sure the land was never better prepared than it now is. There has been nothing left undone that possibly could have been done to insure proper planting conditions. The farmer has not taken it out in talk and criticism, but has determined to do his part, as best he can, to bridge the gap between depression and prosperity. It now behooves our Government to assist him in his undertaking, even as it has seen fit to assist other branches of industry. If this assistance is forthcoming immediately, it will be a wonderful incentive and boon to an industry that has every reason in the world to feel despondent.

Of course, there will be those who will oppose your measure. There will be proponents of plans to let the independent and private insurance companies take up this work. But I state to you that they have tried it. In the past two years there have been companies who have issued crop insurance, but this year they advise us that they will not be in the field, as their operations have necessarily, because of lack of capital, been confined to small scopes of territory, and when failures hit them there they lost money. Surely the least that can be done is to investigate the feasibility of the idea, and if in any way my services to you will assist, please consider that I will count it a privilege to serve."

"Agriculture is the only industry that can not obtain insurance--" writes Mr. T. C. Power, president of the Bismarck Bank, Bismarck, North Dakota, in a letter to Senator McCumber.

"It can not buy insurance. If it could, bankers would furnish money for the cost of seed and labor. The Hartford Insurance Co., a splendid institution, has for the past two years done a limited amount of crop insurance business, but has raised the rates and placed restrictions so that it at present affords but little facility, as no one insurance company can afford to carry the entire risk of this line in the United States.

I myself have had crop insurance during the past two years and have collected insurance--that is, the actual cost of the investment where I lost the crop, and where there was no loss I succeeded in raising a sufficient crop to more than pay for carrying on the industry.

The rate charged by the Hartford Insurance Co. two years ago was 8 percent and last year 9 percent, but it paid the parties who took out the insurance even at this high rate."

In its issue of February 3, 1922, Wallace's Farmer, of Des Moines, Iowa, urges crop insurance as follows:

" CROP INSURANCE"

"The farmer in growing crops faces the uncertainties of weather, insects, diseases, and markets. When he plants in the spring he does not know whether he shall secure in the fall a high yield at a high price, a low yield at a low price, or a low yield at a high price. He is at the mercy of hundreds of powerful forces altogether beyond his control.

The business man who has perhaps ten times as much control over his production conditions and his market as the farmer nevertheless removes uncertainty even more from his business by insurance. The business man insures extensively against fire, theft, death, and a dozen other contingencies. Now, it occurs

to a business man that it might be well for farmers to use insurance far more extensively than they do. Theodore Price, editor of Commerce and Finance, in an open letter to Secretary Wallace, suggests that the Department of Agriculture establish a crop insurance bureau. Mr. Price, like all business men, is rather against putting more Government into business, but thinks that it might be well for the Government to start a project of this sort, insuring typical farmers in representative crop-growing areas, with the idea of securing data after a number of years upon which rates might be worked out for a vast new insurance system.

Insurance is really a practical form of socialism. It spreads risks over society as a whole instead of allowing them to burden the individual who may not be able to bear the accident which occasionally strikes him. For instance, at the present time there are thousands of splendid hard-working young farmers who are practically bankrupt through no fault of their own. On the average the best farmers win through in spite of weather and markets. Nevertheless there are thousands of cases where really splendid men have lost out merely through the accident of weather and markets. They were figuring on an even break of 'heads and tails,' but instead 'tails' came four times straight and they were ruined.

Mr. Price's suggestion is excellent. Perhaps the Department of Agriculture should not actually establish a crop insurance bureau, but it certainly should be at work on the fundamentals of crop insurance. How can the most good be accomplished by distributing over society as a whole the risks of weather and the market?"

Crop insurance should receive the serious and favorable consideration of Congress, according to Dr. Andrew M. Soule, president of the State College of Agriculture of Athen, Ga. He writes as follows:

"There is no reason why crop insurance should not be instituted and made an effective agency in helping to maintain a desirable equilibrium in our production and distribution of food crops. Undoubtedly insurance has proven of benign value to many phases of our industry that would have languished but for the fact that those engaged in the business were in position to insure themselves against loss. The practicability of crop insurance appeals to me, and I am disposed to think that the producers of the country are entitled to this encouragement and protection on the part of the Government. It seems to me that it is a national question, and should therefore be handled through a governmental organization.

It would no doubt be difficult to work out a correct and desirable basis of rates to apply because of the variabilities in soils and the use of fertilizers and seed, the individual

differences existing between landowners, and the effect which climatic conditions in a given year may exercise on crop growth. The Government, however, could experiment along these lines and soon, it seems to me, determine rates which could be applied with profit and advantage. It this were a cooperative mutual aid organization any great accumulation of funds, should the rates prove too high, could be returned as premiums to the insured at the end of any given year, or else applied in the succeeding year to the reduction of the premiums which would otherwise be paid. Removing the gambling element from agricultural production would go a very long way toward stabilizing our primary industry. It seems to me, therefore, that it is a matter which should engage the serious attention and favorable consideration of Congress at this time."

The situation with regard to crop insurance is ably reviewed by Mr. Theo. H. Price in an article in Commerce and Finance, February 15, as follows:

"Indorsement of the idea has come to us from every section of the country. If all those who have written to us and all who believe the possibility is worth investigation will write to their Senators the pressure will force consideration of the resolution.

The benefits to be derived from crop insurance are self-evident. The need is for further light on the practical problems involved, a light which can best be shed by Government research. Write today."

D. G. O'Shea, president of the Federal Land Bank of Spokane, Wash., one of the early proponents of crop insurance, wrote in the Red Cross Echo:

"It does not seem reasonable to expect the farmer to continue to take all the chances. It is not suggested that he should receive something for nothing, but that a method should properly be devised for affording him a reasonable protection for the chances he necessarily has to take when contending with the elements, over which no control can be exercised.

In past years grain crops in Montana were seriously menaced by hail. Hail insurance companies were in business, charging exorbitant rates and at times defaulting in payments. There is now in effect a State hail-insurance law, which is operating successfully, economically, and dependably, and affording protection to the farmers who elect to become subject to it, so that in the event of destruction of a field of grain by hail they will receive at least more than they have invested in the crop.

Some such method should be devised to protect the farmer against other failure. It is not to give him charity or a

gift, but to furnish him with insurance, to the end that he will be sure to receive at least what it has cost him to plant the crop, plus a small remuneration for his labor in the event that there be an absolute failure caused by weather conditions over which he could exercise no control.

Such insurance should be national. If adopted at once it would bring hope and inspiration to those who are now seriously discouraged, and would keep on the farms many men who otherwise would answer the call of the manufacturing centers where life may be more alluring and rewards are definite and assured.

A scheme of insurance can readily be worked out under the operations of which no unworthy person could receive a benefit; the cost may be borne by the farmers themselves or the National Government may contribute to the fund; the fund should be administered by the Government.

Provision may be made to prevent the application of the law to areas not cultivated in the past until after same would have been examined and reported upon by representatives of the Department of Agriculture to the effect that such localities are reasonably adapted to agricultural pursuits. Reasonable provision can easily be devised for determining losses, which may be limited to a stated maximum figure sufficient only to cover the cost incurred and a small margin for labor and living expenses.

There seems to be a specific need at this time for this form of legislation; the operations of the Federal land banks can be better assured and extended if such insurance be provided; and many who naturally will become discouraged at repeated failures may be kept on the farm and inspired to make renewed efforts if a means be provided to insure them a small return for their labor even though the elements be against them."

Cyrus H. McCormick, chaiman of the International Harvester Co., in the Chicago Journal of Commerce goes into the basic agricultural problem with his usual acumen:

"Even though crops are now selling below cost of production, it is not visionary to consider the possibility of a food shortage. The world's population constantly increases and the total area of arable land remaining to be brought under cultivation steadily decreases. The margin between production and consumption of food staples is now, and always will be, so close that even partial failure of a major staple crop would present the serious problem of how to tide the world over until another crop.

With improved farming machinery, a constant increase of cultivated acreage has been for the last half century or more

sufficient insurance against food shortage, but as that increase of acreage grows less and less possible this protection is disappearing. Hence the importance, from this viewpoint alone, of providing reserves of foodstuffs.

America has repeatedly been an importer of wheat in the past. The indications today are that while the 1921 crop was sold below a fair price, the surplus going abroad at less than the cost of production, it is possible, and even probable, that we shall be importing wheat in 1922. Aside from the question of food supply, these facts constitute a powerful argument for a better system of crop marketing.

Under such a system the farmer could avoid the necessity of selling under pressure at too low a price, and the world's greatest grain growing Nation would be spared the economic absurdity of importing wheat to meet its domestic requirements.

Nations and municipalities provide sinking funds against future contingencies. Any well-managed business builds up reserves in prosperous times against such a period of strain as the present. Why, then, should not we make an effort to provide a reserve as insurance against shortage of the essentials of life, when such provision would in a great measure stabilize the value of the farmer's crops and also would protect the whole people against the distress that inevitably would follow any serious shortage in the world's food production?

Immediate relief for our agricultural classes might be found in better financing--in the making available of sufficient funds at reasonable rates, and thus enabling the farmers to 'carry on' until the conditions improve.

Immediate financial relief should not be considered solely as 'firstaid' treatment. If funds are more readily available in emergencies at more equitable rates of interest, the necessity for forced marketing of crops would disappear and the marketing would be done more systematically, with a consequent gain in the average price received.

In some of the older countries grain crops are not rushed to market in any such brief period as with us, but are stacked in sheds or under other cover and are threshed and marketed throughout the year. With better storage facilities and financing the American farmer could, by a similar process, avoid some of the loss incurred by throwing almost the entire grain crop upon the market within a short period and thereby depressing the price.

Let us not deceive ourselves into thinking that our agricultural problem will be solved if the farmer is restored to the relative position he occupied before the war. The farmer can not hope through future years to obtain in the enhanced value of farm lands the reward for his heavy toil. This may occur in some localities, but in the main that condition has passed and the farmer must now receive a better and more dependable return for his efforts than in the past if he or the rest of us are to enjoy real prosperity in the future."

Source: Congressional Record, Vol. 62, Part 13, 67th Congress 2d Session, Mar. 3, 1922, pp. 13522 to 13524.

APPENDIX C

CROP INSURANCE--IS IT FEASIBLE?

(By Theo. H. Price, editor of Commerce and Finance, a paper submitted at the agricultural conference convened at the instance of the President in Washington, January 23, 1922.)

In my study of the agricultural problem that we are asked to consider I find myself asking whether a partial solution of it is not to be had by a resort to crop insurance. I submit the suggestion in the form of a question rather than as a recommendation, because it is plain that much thought and investigation will be required to determine whether the hazards of agriculture are insurable. During the last two centuries the principle of insurance has been greatly extended in its application. The first "underwriters" were the merchants who wrote their names under an agreement to share the marine risks and losses to which the ships and cargoes of their fellow merchants were subject.

The business of fire insurance was next developed.

Then, as the law of probabilities became better understood, life insurance began to be written, and the business has grown until in the United States alone there are 40,000,000 policyholders in life insurance companies or associations whose resources are in excess of $7,000,000,000. No one will deny the benefits of life insurance.

After life insurance came accident insurance and credit insurance, and now we can insure against losses caused by burglary, defalcation, rain, snow, hail, and tornado, as well as against war, unemployment, old age, strikes, and many other ills or accidents of life. It is said that at Lloyds in London policies have been written that called for the payment of a "total loss" to parents to whom twins were born, and just before the disarmament congress met in Washington the New York Times reported that 15 percent was paid at Lloyds to insure that the British West Indies would not be surrendered to the United States by or before December 31, 1922, in full or partial payment of Great Britian's debt to this country.

Crop Failures Cause National Crises

From a very remarkable essay upon "War and Insurance" written by the late Prof. Josiah Royce, of Harvard, just after the outbreak of the World War in 1914, I quote the following passages:

> "Experience shows that the insurance principle comes to be more and more used and useful in modern affairs. Not only does it serve the ends of individuals or of special groups of individuals, it tends more and more both to pervade and to transform our modern social order. It brings into new syntheses not merely pure and applied science but private and public interests, individual prudence, and discourages

recklessness and gambling. It contributes to the sense of stability. It quiets fears and encourages faithfulness.

Floods, famines, pestilences, earthquakes and volcanoes may interfere in various fashions with the economic as well as with the rest of the social life of the peoples thus afflicted. Apart from actual famines, the considerable failure of their crops may impair, for a season, the normal supplies of individual nations. Internal crises, social and political, may interrupt their healthy development in ways involving not only moral disasters but heavy expenses. Such evils come upon various nations with irregularly recurrent, but also with widely different weight and seriousness. Only a vast and long continued collection and an exceedingly difficult statistical analysis of the facts regarding such calamities could determine the regularities which a sufficiently large number of instances of national disaster would be, if properly studied, certain to show. Such regularities, however, if once discovered, would furnish an 'actuarial basis' upon which an insurance of individual nations against such risks could conceivably be undertaken."

And in the eleventh edition of the Encyclopedia Britannica, in the article upon "Insurance" written by Charlton Thomas Lewis, Ph.D., a great authority upon the subject, I find these words:

"The value of insurance as an institution can not be measured by figures. No direct balance sheet of profit and loss can exhibit its utility. The insurance contract produces no wealth. It represents only expenditure. If a thousand men insure themselves against any contingency, then, whether or not the dreaded event occurs to any, they will in the aggregate be poorer, as the direct result, by the exact cost of the machinery for effecting it. The distribution of property is changed, its sum is not increased. But the results in the social economy, the substitution of reasonable foresight and confidence for apprehension, and the sense of hazard, the large elimination of chance from business and conduct have a supreme value. The direct contribution of insurance to civilization is made not in visible wealth but in the intangible and immeasurable forces of character on which civilization itself is founded. It is preeminently a modern institution. Some two centuries ago it had begun to influence centers of trade, but the mass of civilized men had no conception of its meaning. Its general application and popular acceptance began within the first half of the nineteenth century, and its commercial and social importance have multiplied a hundredfold within living memory. It has done more than all gifts of impulsive charity to foster a sense of human brotherhood and of common interests. It has done more than all repressive legislation to destroy the gambling spirit. It is impossible to conceive of our civilization in its full vigor and

progressive power without this principle, which unites the fundamental law of practical economy, that he best serves humanity who best serves himself, with the golden rule of religion, 'Bear ye one another's burdens.'"

Insurance The True Socialism

It might almost be said that if insurance were universal and included all the hazards of life it would be a practicable form of socialism, for it distributes the losses of the few among the many without diminishing the incentive to individual effort. But the question is, Can it be applied to the hazards of agriculture and would the Government be justified in undertaking it? We all know that one of the farmer's greatest difficulties is that he is compelled to be a speculator and to take risks that are not calculable. He is, in fact, a gambler against his will, for gambling is defined as hazard without calculation in contradistinction to speculation, which is hazard with calculation. The farmer must cultivate his land or see it go to waste. He has to plant some crops, such as winter wheat, in the autumn and others in the spring, but he can not have any assurance of the prices that will be obtained for them 6 or 10 months later. He is, moreover, exposed to the hazards of the weather and innumerable agricultural pests in the interval.

The merchant who is not reasonably certain that he can sell goods will not buy them or will reduce his inventories, and the manufacturer who is not assured of a profitable market for his product will shut down his factory and let his labor remain idle. But the farmer can not follow these examples. He has to plant his land at planting time or allow his investment to remain idle and deteriorate for a year.

If he decides to plant he will probably become a borrower in obligations that mature concurrently with his crop. The whole financial system of the northern hemisphere is organized upon a plan which contemplates an autumnal liquidation of agricultural debts. Within one or two months the farmer is compelled to sell the crops that represent the labor of the year just ended and the world's consumption for another year just commencing. The result is congestion and a buyers' market, in which the seller is at a great disadvantage.

What is the remedy? Surely there must be one. If it is to be found in crop insurance it should be speedily applied.

Crop Insurance Not A Novelty

Crop insurance is not a new idea. At least two joint-stock fire insurance companies and several mutuals have tried it, but they had no experience upon which to base rates and found that in order to get a fair average they would have to blindly accept risks so large that their capital might be jeopardized. Even to those who know but little about the science of underwriting it is plain that a very large number of widely scattered crops would have to be insured before the probable percentage of loss could be ascertained.

A rate so high that it would absolutely protect the insurer would be regarded as extortionate and no one would take out a policy, while a rate that was too low might bankrupt the underwriter if he did a large business or had many risks in one locality.

Then there is the question of determining or measuring the farmer's loss. Manifestly it would be unwise to allow him to insure his crop for any valuation he chose to put upon it. An overvaluation would be an incentive to neglect and extravagance and would lead to the presentation of many unfair or fictitious claims. On the other hand, an undervaluation would not give the protection required.

In so far as any rule has been applied by those companies who have written crop insurance the practice seems to have been to insure the actual cost of production up to a certain maximum per acre and to require that the farmer insured must furnish satisfactory proof that the amount claimed has been actually expended.

In some cases crop policies have also contained a provision making the farmer a coinsurer for 20 percent of the risk, so that he would have an additional incentive to avoid loss. The price of the crop insured at planting time is another factor that must be taken into consideration if the indemnity provided is to cover a possible deficiency between the proceeds finally realized at harvest time and the ascertained cost of production.

It seems reasonable to assume that if prices were low when the crop was being sown the risk would be less than if prices were high. The cost of production would be smaller and the chance of an advance in values that would offset crop failure would be greater. As a generalization, therefore, we may conclude that rates ought to have a direct relation to the prevailing values for agricultural products when the policies were written. But in its other aspects the problem is not so simple.

Farm Survey Practicable

The cost of producing a crop varies in different regions or on different lands. In the Atlantic States fertilizer is required to produce a good cotton crop. In Texas fertilizer is not used. The cost of labor also varies in different sections.

These are factors that would have to be taken into consideration in determining the insurable maximum of production costs.

It might be necessary to have each insured farm surveyed in order to fix rates and insurable values fairly. This would seem to involve an appalling amount of detail; but does it? Every building in almost every city and town of the United States has been surveyed in the interest of the fire insurance companies.

In most fire insurance offices there are to be found huge books of maps on which the area, height, construction, fire exposure, and hazards of every building in every city of the United States and Canada are

accurately set forth. These maps are made by pasting the maps on new buildings over those which have been demolished.

According to the last census there are 6,448,336 farms in the United States. The number of buildings in our cities is not known, but New York City alone has over 600,000 and the total in all cities is probably well over 6,000,000. If they can be mapped as they are, the feat of surveying the farms would not seem so difficult and the information in regard to soil, area, and productivity thus made available would be invaluable.

With it as a basis equitable rates for writing crop insurance could be speedily established, and, with a crop insurance policy added to the other security that a farmer can offer, his financial problem would be much simplified.

The general use of crop insurance would benefit the farmer and the country in many other ways upon which it is not now necessary to elaborate. The fact that the farmer could if he chose protect himself against the great risks and ruinous losses to which he is now exposed is a sufficient reason for considering whether the Government ought not to provide the machinery and credit requisite if crop insurance on a large scale is to be made immediately available.

Most people are wisely opposed to having the Government enter any business that its citizens can handle, but here is a business that private capital can not undertake because of its novelty and magnitude. Would it not therefore be well for the President or Congress to immediately appoint a committee to make a careful study of the subject with a view of ascertaining whether it would be practicable and expedient for the Government to establish a crop insurance bureau from which the farmer could buy policies that would indemnify him for his actual and reasonable expenditure and from which, after a few years, the larger insurance companies who were willing to do the business could obtain data upon which to base rates?

War Risk Insurance Profit $17,000,000

Shortly after the outbreak of the war on the 1st of August, 1914, the British Government undertook to insure the marine war risks to which vessels and cargoes under its flag were subject. Almost concurrently, the then Secretary of the Treasury, Mr. William G. McAdoo asked Congress for authority to organize an American war risk insurance bureau for insuring hulls and cargoes under the American flag. The necessary legislation providing an initial fund of $5,000,000 was passed. The bureau was organized and was functioning by the 2nd of September, 1914. It continued in existence until the end of the war. Its record is remarkable.

The total of the policies insured was $2,250,000,000. The premiums received amounted to $46,000,000, and the losses paid were $29,000,000, leaving a profit of $17,000,000. The expense of conducting this enormous business for the four years was only $165,000, or hardly more than

one-third of 1 percent upon the premiums received. When compared with the cost of conducting the insurance business under private auspices these figures seem to be almost incredible and they are an effective refutation of the frequently repeated assertion that Government management is always inefficient and extravagant.

It is, however, only fair to say that the bureau had the advantage of being able to commandeer the services of some of the ablest underwriters in America. Its director was William C. DeLanoy and its advisory board consisted of Hendon Chubb, William N. Davey, and William R. Hedge. For little or nothing these men gave their time to the work as a war duty, and while the great success of the bureau was largely due to the authority and credit of the Government it would be uncandid not to recognize the share that those named and many others had in the results achieved. As the business grew Congress appropriated a further $45,000,000 as additional working capital for the bureau, but not a dollar of the total of $50,000,000 put at its disposal was ever drawn, as almost from the first the premiums received exceeded the losses and expenses incurred.

I have been unable to obtain exact information with regard to the insurance business conducted by the British Government, but those that are "in the know" believe that it was also highly profitable and it is generally admitted that both the American and the British bureaus rendered a very substantial and necessary service to the shipping and trade of the respective nations.

If Ships, Why Not Crops?

In an article published in the New York Times of Monday, December 26, 1921, advocating a ship subsidy there is included a proposal that "the Government should create a nonprofit making corporation to insure its own ships and to offer hull insurance at cost to privately owned American vessels." It is explained that "for the organization of a nonprofit making insurance corporation a $10,000,000 loan will be necessary" and that the cost of handling cargo insurance is estimated at about $1,000,000 for the first year and a decreasing amount each year thereafter, the loss ultimately vanishing.

If the Government is willing to do this for shipping it ought not to hesitate in doing at least as much if not more for our infinitely more important agricultural industry, and I earnestly recommend the idea to its consideration.

The difficulties that seem so great in prospect would, I believe disappear in practice, and it is highly probably that after the first year or two the business would show a profit and produce an income that would more than pay the cost of conducting."

Mr. SHEPPARD. The conference itself then passed a resolution on the subject, urging that an investigation be made, and I ask to have the resolution set out in the Record.

The PRESIDING OFFICER. Without objection, it is so ordered.

The resolution referred to is as follows:

January 25, 1922

REPORT OF SUBCOMMITTEE ON AGRICULTURAL INSURANCE

Whereas the Government through scientific research has provided safeguards for agriculture and the live-stock industry against plant and animal disease; and

Whereas farmers are subject to the hazard of loss from insect depredation or other pests, or loss from the elements, against which they have no present means of protection; and

Whereas the furnishing of such protection would greatly stabilize and materially improve the credit risk of our national agriculture; Now, therefore, be it Resolved, That this National Conference on Agriculture recommends that the United States Congress take steps to investigate the subject of crop insurance with the view of determining the practicability or expediency of creating a crop insurance bureau.

Source: Congressional Record, Vol. 62, Part 3, 67th Congress 2d Session, Feb. 7, 1922, p. 2212.

APPENDIX D

WHAT CAUSES HAIL

(By Ray Ozmon, Roving Reporter, Montana Farmer-Stockman, July 1, 1956)

Is there anything that can create more mixed feelings of fascination and downright horror than a hail storm? Watching the pellets of ice level a grain field, bounce off buildings, dent car roofs and shatter windows, we get a terrifying glimpse of nature's destructive indifference. We can't help but wonder at the strange conditions that must exist in the heavens to cause 2-inch hail stones to fall out of a mid-summer sky.

Although a person realizes his complete helplessness in the face of a hail storm, he may wonder why it isn't possible to get some warning from the weather bureau so he could at least get his livestock and machinery under cover. But the very nature of hail storms makes them difficult to predict with any degree of precision.

Hail is born in a thunder storm. These storms release their violence in small, concentrated areas and are usually of short duration. The weather bureau can anticipate conditions that might lead to thunderstorms and can issue a general forecast 12 to 18 hours in advance for "scattered thunder storms" for an area of about 10,000 square miles. But trying to pinpoint in advance where these violent weather eruptions will occur within the 10,000 square mile area is practically impossible.

Two conditions are necessary for thunder storms and hail: Moisture and turbulent, unstable air.

Water vapor is always present in the atmosphere in varying amounts. It's the amount of water vapor that determines the intensity of rainfall or the size of hail stones. Thunder storms are usually preceded by warm, southerly winds which originate in the tropics and carry a high percentage of water vapor.

Several factors can cause the air to be unstable. A layer of surface air may be heated by the sun and sent skyward. If the air aloft is comparatively cold, the rate of ascent will be greatly increased. River valleys and mountains will deflect air currents frequently, causing them to converge and adding to the turbulence. As the air rises, water vapor condenses to form billowing thunderheads, or cumulo-nimbus clouds. When the air becomes saturated the moisture falls to the ground.

When the air is boiling in an unstable state it can rise as high as twenty, thirty or even forty thousand feet, where the temperature may be below zero. This heavy, super-cooled air then falls back to earth along the outside of the column of up-drafts. Rain falling inside a column of rising air can also cause down-drafts within the column itself. When these down-drafts strike the earth the air surges out to the sides creating violent gusts of wind. If there is sufficient boiling and turbulence, a hail storm will result.

When the air becomes saturated and releases its moisture high in the atmosphere, it first falls as snow. As it descends to about 10,000 feet, it melts. It's the commonly accepted theory that when the air is churning in a turbulent, unstable state, the drops of rain are caught in an up-draft and tossed back up to the sub-freezing atmosphere where they freeze and become hail stones.

As they fall back to earth the hail accumulates more moisture and increases in size. This process may be repeated several times until the hailstones become so large and heavy that the up-drafts can no longer support them, and they come crashing to earth. Sometimes hail will be caught in a down-draft and strike the ground with a force far greater than the pull of gravity.

The hailstorm that devastated Billings the afternoon of July 6, 1955, is a classic example of the weather phenomena that cause hail and of the difficulty involved in accurately predicting it.

The 9:30 a.m. forecast for Billings on July 6 stated that hail was likely. At 12:30 p.m. the weather bureau announced that some areas in southeastern Montana definitely would have hail. Twenty minutes before the storm hit Billings radio stations were alerted.

In view of the unpredictable nature of hailstorms, how was the weather bureau able to anticipate the storm? Herb Huennkens was on duty at the Billings Weather Bureau the morning of July 6. He says that there were nine grams of water vapor per kilogram of air. Three and a half grams is normal.

Studying weather maps and reports from other stations, he observed that a cold Pacific front was headed in the general direction of Billings from the northwest. At the same time a moist tropical air mass was moving up from the Gulf, curving through Nebraska and South Dakota. If these two air masses continued on the same course it seemed likely that they would converge somewhere in southeastern Montana. If this happened there would be a strong possibility of thunderstorms.

The dew point, the temperature at which vapor condenses into rain, was 60 degrees. Normally it's around 30 degrees in the Billings area. Temperatures in the upper atmosphere were unusually cold, which could accelerate upward movements of warm air. So in addition to a high moisture content, there were conditions that could cause turbulent, unstable air. Therefore, the forecast for the southeastern part of the state for the morning of July 6 was for scattered thundershowers with the possibility of hail.

By noon it was evident that the cold Pacific front approaching from the northwest and the warm, moisture-laden tropical air mass looping around through Nebraska and South Dakota were continuing on their prescribed courses. The conditions conducive to hail had intensified. Hail was a definite possibility, as was stated in the 12:30 p.m. forecast. But it was impossible to predict just when or where it would strike.

While the weather observers were watching these two air masses converge on southeastern Montana, a low-altitude jet stream was moving up through Lander and Sheridan, Wyo., straight for Billings. When the jet stream arrived over Billings it would intensify the instability of the moisture-laden air near the surface, causing it literally to explode skyward into the cold, sub-freezing atmosphere.

Huennekens issued a special hail warning at about 1:45 p.m. Shortly after 2, Billings was pelted with tons of ice. Damage was estimated at $6 million. It was the most severe storm in the history of the Billings Weather Bureau.

While the largest hailstones reported were over three inches in diameter, they undoubtedly melted some while falling to earth, and naturally, no one is going to run out with a ruler to measure them the moment they strike the ground. Their size was probably reduced somewhat through melting from the time they fell until the storm subsided.

As you gaze from the kitchen window this summer and watch a hailstorm pound your 30-bushel wheat crop into the ground, you can at least have the dubious satisfaction of knowing that in a 10,000-square-mile area Mother Nature selected your farm to put on one of her most violent displays of feminine temperament. And if you paid the premiums on your hail insurance, perhaps you can find some source of amazement in contemplating the unusual weather conditions that created this devil's manna.

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