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Vol XIX
No. 1

ISSN 0019-5014

CONFERENCE
NUMBER

JANUARY-
MARCH
1964

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS



INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

inter alia, from the failure in farming methods, storage and processing. Credit itself may reduce risks by providing the means to obtain improved seed, plants, livestock and implements, or undertake farm improvements. But the relationship between techniques and credit again warrants the reiteration of the importance of associating with provision of credit, agricultural extension and the organization of the supply of improved seed, plant, implements, etc. In short, credit should form an integral part of an overall economic development programme of agriculture.

RISK AND UNCERTAINTY IN AGRICULTURE: IMPLICATIONS FOR AGRICULTURAL CREDIT

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INTRODUCTION

A great many problems faced by both farmers and lenders in financing agriculture are closely associated with risk and uncertainty. Unfortunately, little serious attention has so far been given to these problems by either research or service institutions in India. The objective of this paper is to examine some of the possible effects of risks and uncertainties on financing of agriculture and indicate the nature and type of research and services needed to help farmers and lenders in their decision-making framework, and Governmental agencies in the formulation of policies and programmes pertaining to financing of agriculture.

The two terms 'Risk' and 'Uncertainty' have been defined and differentiated in the writings of Frank H. Knight, Earl O. Heady, and others.¹ Under the present Indian conditions, however, it is generally not possible to make an empirical distinction between risk and uncertainty due to lack of adequate quantitative research.²

* The views expressed herein are personal and do not reflect those of the Department or the Government.

Sincere thanks are due to Dr. John W. Mellor of Cornell University, presently visiting Professor of Agricultural Economics at Indian Agricultural Research Institute for his valuable comments and suggestions.

1. For further details, please see Earl O. Heady: *Economics of Agricultural Production and Resource Use*, Prentice-Hall, Inc., New Jersey, 1952, pp. 439-443; and Frank H. Knight: *Risk, Uncertainty and Profit*, Kelley & Millman, Inc., New York, 1957, pp. 233.

2. No distinction is made, in the next part of the paper, between risk and uncertainty except as is evident from the discussion. The distinction between the two terms is, however, important for the last part of the paper where suggestions with a view to convert certain uncertainties into risks are made.

The risks and uncertainties in agriculture can be classified under five types, arising out of : (i) variations in production due to natural hazards ; (ii) price changes ; (iii) technological changes ; (iv) actions of the people, organisations and agencies the farmer does business with ; and (v) unfavourable outcomes affecting the health and ability of the operator or his family. The technical risks, in general, are not yet so important due to limited use of technological innovations. But, the increased use of improved agricultural practices and techniques would increase the magnitude of technical risks both to the farmers as well as lenders.

EFFECTS OF RISK AND UNCERTAINTY

By and large, the probability and extent of losses likely to result from risk and uncertainty in agriculture affect the following: (i) capital investment in agriculture; (ii) cost of credit; (iii) security requirements for loans and, therefore, the dispersion of loans between the small and large growers ; and (iv) distribution of loans between purposes and so also between terms—short, medium and long. No particular priorities in matter of sequence can, perhaps, be given to the discussion of one aspect over the other because of their overlapping relationships.

Effect of Risk and Uncertainty on Capital Investment

In the absence of uncertainty, the farmer would use capital in quantity to equate its marginal cost (MC) and marginal value productivity (MVP). Under risk-situation where cost can be assigned to the probable losses because of better knowledge of probability of the variations, the farmer does try to equate marginal cost and the marginal value productivity. In case of uncertainty he does not know what the risk premium is; as a result he may understate it and therefore use capital where *ex post* MC is greater than MVP. However, since farmers tend to be conservative it is more likely that in the face of uncertainty the farmer will overdiscount so that *ex post* MC is less than MVP. The overdiscounting for loss in the face of uncertainty will be particularly severe in the case of borrowing for there the penalty of an error would be greater. The effect of such overdiscounting is to lower input and production levels. Similarly the lender, if he knew that every loan made would be repaid, would find it profitable to loan the money to a point where the rate of return is equated with the rate of interest. But, again, uncertainty may cause lenders to make *ex ante* decisions which *ex post* do not equate marginal costs and returns.

The owner-operator with full equity (owning all the capital) may lose part of his capital due to risk and uncertainty, but when credit is employed the loss is multiplied according to the "principle of increasing risk" (the tendency for risk to increase as owner-equity in a business decreases).³ The principle of increasing risk affects the lender also exactly the same way as the borrower, when the lender uses others' money to make loans.

The farmer is prejudiced, not only by the losses which he may have to incur if the risks eventuate, but also by the higher price which he has to pay for loans

3. W. G. Murray and A. G. Nelson: *Agricultural Finance*, the Iowa State University Press, Ames, Iowa, 1961, pp. 120-121 ; and Earl O. Heady: *Economics of Agricultural Production and Resource Use*, pp. 543-544.

because of their probability, whether they actually occur to him or not. Some farmers may also wish to maintain reserves of borrowable funds for the purpose of taking advantage of favourable opportunities or to adjust to unfavourable situations, as and when they come to them. Likewise, the creditor is also prejudiced. He may fail to collect the whole or a part of the interest or the principal or both. As a result, the lender does not generally provide loan funds in amounts which would equalise the rate of return and the interest rates when applied to the operation of a particular firm. He also discounts the interest that he charges. In addition, he finds it advantageous to maintain reserves of the loanable funds for purposes of taking advantage of favourable opportunities and of adjusting to unfavourable situations. This leads to what Schultz states as a presumption, that "there exists for agriculture both external and internal capital rationing."⁴

In the United States a number of empirical studies have been made on capital rationing. Results of some of these studies⁵ provide evidence that the farmers in the United States were little affected by external capital rationing. Most of them, however, were practising internal capital rationing and "uncertainty fears" in one form or the other were the potent causes responsible for it.

Little data on the relative importance of internal and external capital rationing are available in India. However, the Rural Credit Survey provides some data concerning the credit requirements of the cultivators in relation to the possibility of a reorganized credit system and also in relation to certain standards of technical production. About two-thirds of the cultivating families both in the upper as well as in the lower strata indicated that they experienced difficulty in obtaining finance for current expenditure on farm.⁶ Further, the credit requirements reported for the three specified items of investment, *i.e.*, purchase of land, purchase of livestock, and other capital expenditure in agriculture were found to be much larger than the actual expenditure incurred on them, both in the case of upper and lower

4. T. W. Schultz: *The Economic Organization of Agriculture*, McGraw-Hill Book Co., Inc., New York, 1953, p. 306.

5. Those interested in details would find the following studies very useful :

- (i) Earl O. Heady and Earl R. Swanson: *Resource Productivity in Iowa Farming with Special Reference to Uncertainty, and Capital Use in Southern Iowa*, Iowa Agriculture Experiment Station Research Bulletin 388, 1952.
- (ii) Leon F. Hesser and Melvin R. Janssen: *Capital Rationing Among Farmers*, Indiana Agriculture Experiment Station Research Bulletin 703, 1960.
- (iii) Earl O. Heady, R. J. Hildreth and Gerald W. Dean: *Uncertainty, Expectations and Investment Decisions for a Sample of Central Iowa Farmers*, Iowa Agriculture Experiment Station Research Bulletin 447, 1957.
- (iv) *Farm Credit Administration: Some Highlights of Selected Studies on Farmers' Attitudes Toward the Use of Credit*, Research and Information Division, Washington 25, D. C., 1962.
- (v) Donald S. Moore and R. J. Hildreth: *Adjustment Problems and Goals of Dryland Cotton Farmers on the High Plains*, Texas Agriculture Experiment Station, M. P.—323, 1959.
- (vi) National Analysts, Inc., *Farmer Attitudes Toward Credit and Sources of Credit*, Philadelphia, 1960 (Study made for the Farm Credit Administration).
- (vii) Loyd K. Fischer: *Farmer's Use of, Attitude Toward and Knowledge of Credit*, Farm Credit Banks of Omaha, Omaha, Nebraska, in co-operation with University of Nebraska, 1961.

6. The Reserve Bank of India, *All-India Rural Credit Survey, Vol. I, The Survey Report, Part I (Rural Families)*, Bombay, 1956, pp. 993 and 997.

strata of cultivators.⁷ Although the data on reported credit needs as well as their comparison with the actual expenditure incurred suffer from apparent weaknesses, they provide evidence of external capital rationing in Indian agriculture. No factual information on internal capital rationing due to risk and uncertainty in agriculture in India is available, but farmers' general reluctance to the use of credit, as far as they can manage without it, provides ample testimony for the presence of this phenomenon.

Effect of Risk and Uncertainty on Cost of Credit

Two important aspects that need discussion here are : (i) effect of risk and uncertainty on cost of credit, and (ii) effect of the cost of credit on investment.

Some of the more important factors that have an effect on interest rates paid on farm loans are : the cost of funds, risk of loss, cost of managing and servicing the loans, custom and precedent, local monopolistic credit conditions, Government legislations setting maximum interest rates, and competition from Government and co-operative credit organisations supplying credit on subsidised rates of interest. The co-operative credit institutions in India have been placed in a special status to establish low interest rates throughout the country through provision of loanable funds from the Reserve Bank of India at the concessional rates of interest as well as through subsidies towards cost of management.

Pure rate of interest is a hypothetical rate and never exists in practice. The regional and other variations in the interest rates arise chiefly from variations in allowance for risks and cost of managing and servicing the loans. Risk enters into the cost of credit by the extent to which the risk to the borrower is transferred into risk to the lender and therefore accounts for higher rates in high-risk situations (areas and enterprises) and on loans with narrow margin of security. Cost of negotiating, managing, and servicing the loans varies in its effect on the rate according to the loan-size, and terms and conditions of repayment. In general, the cost of making the loans is relatively high on small and short-term loans and in high risk-situations and it is proportionately low on large and long-term loans and in low risk situations. The co-operative credit system in India, nevertheless, operates pretty much on the basis of one rate regardless of high or low risk-situations. This, of course, amounts to providing a subsidy to high-risk areas or even enterprises by the low-risk areas and enterprises because the consideration that counts is that the income from the lending business of a particular institution as a whole should cover the losses and management of the organisation. No data are available to indicate the extent to which the cost of credit is affected under various risk and uncertainty situations.

Theoretically, the interest rate is one of the main determinants of the level of investment. If the rate earned on farm capital is less than the interest rates paid, the magnitude of loss widens as the farmer's equity declines; and when the productivity of capital is greater than the costs of credit, profits increase with the amount of borrowing and decline in operator's equity. But, because of the widening range of possible outcomes, farmers view the optimum amount of borrowed capital in a subjective fashion and the level of interest weighs less heavily

7. *Ibid.*, pp. 959 and 961.

than the subjective value which the farmers place on the chance of loss as their equities decline.

The United States studies, referred to under footnote 5, revealed that by and large the interest rates were not a deciding factor in influencing the decisions of the majority of the farmers regarding the use of credit.

The All-India Rural Credit Survey reports that about 25 per cent of the cultivators were willing to borrow at rates of interest less than 3 per cent; 17 per cent at rates between 3 and 5 per cent; 30 per cent at rates above 5 per cent; and about 28 per cent did not reply to the questions. However, in transactions actually recorded, apart from the loans contracted free of interest, most of the loans were reported bearing interest at 5 per cent or more.⁸

Effect of Risk and Uncertainty on Security Requirements

If the farming as well as loaning business were risk-free and the loans were repaid as scheduled, no lender would have raised any question about security. But the adverse conditions affecting farm incomes and so also the loan repayments have to be recognised and to arrange for such an event before it occurs is a prime reason for security. The security required, therefore, would vary in general with the extent of risk involved, which along with many other factors depends upon the size, purpose and period of loans, and the incidence of physical and economic uncertainties. The security requirements in their turn affect not only the extent and directions of capital investment but also the dispersion of the loans between the small and the large growers.

A great many private lenders in India belong to the same village or the neighbourhood as that of their borrowers, have full knowledge about the farming business and the social and economic standing of their clientele, and are in a position to exercise local influence and control over the borrowers and thus force repayments. Loans made by them are also, by and large, of small denominations and short durations. Such loans are generally financed by these lenders on personal security. The lenders, other than these, generally prefer some sort of physical security to protect against any type of losses that may occur. The insistence on material security increases in case of medium and long-term loans and even on short-term loans of doubtful nature. In case of *takavi* loans, the nature of security varies from State to State. Reliance, however, continues to be placed mainly on the value of land which the borrower can offer as security.⁹ In regard to co-operative loans, the Committee on Co-operative Credit observed that by and large, the grant of loans to individuals followed landed property (*i.e.*, against mortgage of land or producing one or two sureties from owners of land) rather than the productive purposes for which the loans were taken.¹⁰ The Rural Credit Survey revealed that in the major States of India, the percentage of advances given by agricultural credit societies against the security of immovable property

8. All-India Rural Credit Survey, Vol. I., Part I, p. 999.

9. Government of India, Report of the Committee on Takavi Loans and Co-operative Credit, New Delhi, 1962, p. 14.

10. Government of India, Report of the Committee on Co-operative Credit, New Delhi, 1960, p. 85.

was more than sixty. The results of the four Follow-Up Surveys also reveal that in 8 out of 37 districts surveyed, crop finance was mainly available on the security of immovable property, in other 10 districts on the basis of first charge on land, and in 14 districts it was available mainly on personal or third party security.¹¹

The insistence on equity basis or physical security, lender's legitimate precaution against risk and uncertainties, has at least two adverse effects: (i) when the borrowers have to furnish immovable property as security even for short-term agricultural finance, they are left with nothing to offer as security for obtaining medium and long-term loans: and (ii) it allows a farmer who has high equity or who can offer physical security to obtain loan for a purpose on which the rate of return is low or even for consumption purposes, while it does not allow a farmer with low equity or who cannot offer physical security to obtain loan even for the purpose where he can realize much higher rate of return. The dispersion of credit therefore is generally to the advantage of the large holders. The Rural Credit Survey supports this observation.¹²

Effect of Risk and Uncertainty on Distribution of Loans by Purpose and Terms

Uncertainty of the market and the productive process is one of the more important factors affecting the distribution of loans. The lenders are apt to favour those loans which are secure regardless whether they are used for productive or non-productive purposes, and whether they are procured for short, medium or long-terms. For the same reasons, they would prefer the low-risk areas over the high-risk areas, and the low-risk enterprises over the high-risk enterprises.

The research studies (footnote 5) in the United States suggested that investment was restricted, to a great extent, in those enterprises which farmers considered risky or uncertain.

The All-India Rural Credit Survey indicated that if additional credit were available for current agricultural operations, 76 per cent of the farmers would like to use it for intensive tillage; 74 per cent for manuring; and 71 per cent for seed. The preference differential was apparently non-significant, may be because the job of framing the questionnaire and canvassing the information was poorly done or the farmers could not think of the alternative use of capital under hypothetical situations properly. Further, the credit requirements reported by the upper and the lower strata of farmers respectively were larger than the actual expenditure incurred by 6 and 29 times for the purchase of land, by about 2 and 4 times for the purchase of livestock, and by 5 and 9 times for other capital expenditure (development of land, digging of wells, purchase of implements and machinery, etc.).¹³

In regard to the duration of loans, the majority of the replies under the Rural Credit Survey indicated that the loans were desired for medium and long-term durations—about 13 per cent of the cultivators desired loans for periods ranging from 6 months to 2 years; of the other 60 per cent or so, about equal proportions

11. H. B. Shivamaggi, "Provision of Credit for Small Cultivators," *Indian Journal of Agricultural Economics*, Vol. XVIII, No. 3, July-September 1963, p. 30.

12. All-India Rural Credit Survey, Vol. II, The General Report, Bombay, 1954, p. 234.

13. Rural Credit Survey, Vol. I, Part I, pp. 959 and 961.

desired loans for periods of 2 to 5 years and for periods exceeding 5 years; and over one-fourth of the cultivators did not reply.¹⁴ No comparisons are, however, possible with the actual state of affairs as under the Survey no data could be collected on the periods for which the loans were actually contracted. All the same, it is most likely that in actual practice a higher proportion of loans were allowed for short-term durations.

Research and Service Needs for Reducing Risk and Uncertainty

Credit problems arising out of risk and uncertainties in agriculture probably require a three-pronged approach:

I. Intensive research for (i) organising to improve the knowledge on the extent and nature of various types of risk and uncertainties; (ii) measuring probabilities with a view to converting certain types of uncertainties into risks; (iii) proper identification of the farm credit problems arising out of risks and uncertainties in agriculture and their impact on agricultural production, both at the farm and national levels, and on farm incomes; (iv) providing a body of knowledge to provide (a) guidance to the farmers in decision-making on the use of capital and credit under their specific farming conditions and resource situations, (b) guidance to the lending institutions, particularly the co-operatives, to plan effective credit programmes—loaning procedures, cost of credit, repayment schedules, follow-up and supervision of the loans, etc., and (c) such information to the Central and State Governments which may be of use to them in laying out sound agricultural credit policies, in line with production economics logic and the most efficient use of resources, to suit the needs of various geographical and/or farming regions of the country, various size-groups of farm holdings, and different types of farming and farm enterprises.

II. Some of the uncertainties in agriculture confronting the farmers arise out of the ill-organised credit system, the procedural matters pertaining to planning and use of credit by the farmers, and the administrative and planning procedures adopted by the lending institutions in advancing loans as well as in fixing the repayment schedules. Methods and procedures can, perhaps, be devised to eliminate or at least mitigate the incidence of such risks. Credit itself may reduce certain risks by timely provision of the means to obtain improved seed, plants, livestock, and implements, and to undertake farm improvements. But the relationship between improved techniques and risk emphasizes the importance of associating credit with a competent and efficient agricultural extension service, supervision, research and experimentation.

III. Identification of the policy areas where the Central or State Governments have to take action in order to reduce such uncertainties in agriculture as cannot be removed, and stabilise farm incomes. Some such steps are: (i) price stabilisation; (ii) insurance against various types of losses; (iii) land reforms providing for security of tenure and free transfer of land; (iv) public health programmes; and (v) an agricultural credit policy fair to both, farmers and the credit agencies.

14. *Ibid.*, pp. 999 and 1004.

It is not possible within the space allowed for this paper to deal in detail with all the three approaches and therefore, only the first two are discussed briefly.

Research Needs

The near vacuum of research on risk and uncertainty as it relates to credit makes a comprehensive listing of research needs impossible. The following represents the tentative views concerning a few critical areas of research.

1. The whole country needs to be mapped out in as few as possible regions and sub-regions on the basis of types of risk, degree of risk (high, medium and low) affecting the agricultural production: and the type of agriculture affecting the credit requirements and credit policies relating to advances, supervision, and repayment of loans.¹⁵ This would call for measurement of the probabilities of variability or outcomes which are measurable in an empirical or quantitative manner. For certain regions the incidence of variations in rainfall, occurrence of floods, droughts and hail-storms, and resulting crop failures could be measured empirically while in other regions it may not lend itself to such measurement.

2. There appears much sense and justification in what Obed Wyum, on the basis of his 45 years' experience of living on the farm and struggling with risk and uncertainty in these years, has stated, "I am rather skeptical about any one getting the whole risk picture of family farm operation except through actual experience."¹⁶ What this signifies is that in any attempt for research on problems relating to the farmers, they should be the first to be approached and referred to. It is, therefore, prudent here also to hold surveys in various parts of the country, representing various soil-climate and agro-economic complexes on such aspects as: (i) farmers' opinions and attitudes towards the use of credit; (ii) farmers' preferences for loans by purposes, security, rate of interest, and credit agencies and reasons thereof; (iii) farmers' knowledge of credit and credit agencies; (iv) farmers' expectations from credit agencies; etc. It may, perhaps, be worthwhile to associate Rural Sociologists and the Social Psychologists in such studies wherever possible.

3. Intensive research is required in the following directions: ¹⁷ (i) *Underuse of capital in agriculture*: (a) techniques of measuring capital underuse, capital productivity and capital needs in agriculture; (b) the extent to which the risk and

15. Several attempts have been made in the past to divide India into various regions for different purposes, such as by Stamp, Simkins and Spate; Census of 1951; Rural Credit Survey 1951-52; Dr. Chen Han-Seng; and Dr. Daniel Thorner. These may perhaps be examined to see how far they are valid to our requirements. For details, please see Daniel Thorner, "Demarcation of the Agrarian Regions of India: Some Preliminary Notes," Seminar on Rationale of Regional Variations in Agrarian Structure of India (Matheran, October 1956), The Indian Society of Agricultural Economics, Bombay, pp. 46-67.

16. Obed Wyum, "The Individual Farmer's Viewpoint and Problems," Proceedings of Research Conference on Risk and Uncertainty in Agriculture, (Bozeman, Montana, August 10-15, 1953), Ag. Expt. Sta. Bulletin 400, North Dakota Agricultural College, Fargo, North Dakota Great Plains Councils Publication No. 11, 1955, p. 30.

17. For comprehensive statements on research needs in this direction, please see Proceedings of Research Conference on Risk and Uncertainty in Agriculture, Earl O. Heady, "Framework of Uncertainty Research and Solutions," p. 13; and Emily N. Castle, "Research Problems Relating to Credit for Areas of High Risk and Uncertainty," pp. 89-90.

uncertainty cause underuse of capital in agriculture; (c) the manner in which the underuse of capital causes inefficiency— does it cause great sacrifice in scale returns; does it cause wrong combinations of capital and other factors of production for any given output; or does it cause the wrong allocation of given capital resources between different products. (ii) *The credit problems of the borrowers in relation to risk and uncertainty*: The research in this field may comprise: (a) analysis of farmers' investment decisions under risk and uncertainty; (b) study of methods farmers use to manage assets to lessen the burden of risk and uncertainty; and (c) comparisons of formal principles and Katona-type rules of thumb for guides in investment decisions. (iii) *The problems of the lenders*: Research studies in this area may pertain to: (a) decision-making framework and policies of lenders; (b) combining management services with credit services furnished to farmers by lenders; (c) risk and uncertainty phenomena from the viewpoint of the lending firm as "buying" and "selling" a resource, credit; (d) possible areas of conflict between borrower and lender, *i.e.*, "capital rationing" phenomenon; and (e) studies related to the reduction in risk associated with a diversified portfolio.

4. As pointed out by Horace Belshaw,¹⁸ risks due to natural conditions may often be reduced by improved techniques such as the use of pesticides, fungicides, improved varieties, strains, and types of crops and livestock, better processing, better storage and improved transport. Even some natural hazards may be reduced by technical means such as irrigation, drainage, flood control, control of animal diseases, and improved cultural practices. Research on some of these technical aspects requires more concerted efforts. Any techniques, practices or technical innovations should be thoroughly tested and experimented before releasing them to the farmers to ensure in general that the techniques are suited to local conditions and within the professional competence of the farmers and the extension service personnel, since the prospect of their failure increases technical risks. Research can point out the existing probabilities regarding recommended innovations and hence the need for improvement.

As stated in the earlier part of the paper, under the present Indian conditions it is generally not possible to make a distinction between risk and uncertainty due to lack of adequate quantitative research. This results in over-discounting by the farmers for the probable losses even in the face of risks, limiting the capital investment in agriculture to a stage much before the point of optimum investment. This highlights the point that efforts to reduce uncertainty will result in a closer approximation of *ex post* cost and returns, and calls for research converting uncertainty into risks with known probabilities.

Action Programmes

It is clear from the preceding discussion that some of the risks and uncertainties confronting the farmers and the lenders arise out of incompetent service providing technical advice to the farmers as well as unrealistic approaches to credit problems—faulty procedures for determining the credit needs, advancing the loans and fixing the repayment schedules. Such risks and uncertainties can be reduced

18. Horace Belshaw: *Agricultural Credit in Economically Underdeveloped Countries*, Food and Agriculture Organization of the United Nations, Rome 1959, p. 99.

to a fairly large extent by providing for (i) competent technical service to advise the farmers on technical aspects of agriculture; and (ii) farm management advisory services both at the farm and the credit institutions level. Budgeting procedures may be adopted to determine the amount of credit it will pay to use as well as to assure that funds will be available to meet loan payments when they come due.¹⁹ The experience of the Production Credit Associations in the United States indicates that "In many instances, it forced farmers to do better planning of their farm operations. It assisted greatly in making sound loan which could be repaid from income and helped avoid over-borrowing."²⁰

A beginning has already been made at the farm level by introducing the farm planning activity in the Intensive Agricultural District Programme. All the first seven districts in IADP are now in the third or the fourth year of implementation of the programme and it is time for stock-taking of the use of farm planning technique and making necessary amendments in view of the experience gained therein. The competency of the machinery providing advice on farm planning and related matters may also need a thorough examination because a technique is no better than the people who use it and an incompetent machinery not only fails to deliver the goods but also harms the programme and discredits the technique.

In regard to the farm management service for the co-operative lending institutions, a beginning has yet to be made and it is perhaps the time to take necessary, even though modest, steps in this direction. Experience of the farm credit organisations in other countries indicates that farm management is an important tool for the creditor as it is for the borrower. To start with, two or three selected Central and State Co-operative banks may add to their staff a small farm management unit. The scheme may be experimented in one or two IADP districts where the banks are in a better position resource-wise and some farm planning facilities at the farm level already exist. If necessary some subsidy can be provided as a help as well as an incentive in the initial period. The service can be strengthened by stages depending upon its effectiveness and resources of the banks. A close co-ordination between the personnel of the farm management service at the farm level and that at the credit institution level would dispel the suspicion of lenders about the soundness of the farm and credit plans. The details regarding size and functions of such service and the qualifications of the personnel to be entrusted with the job in the field or in the banks may require further thought and discussion at the experts level.

A clear understanding of the physical, biological, and economic sources of risk and uncertainty on the part of bank staff is probably a necessary condition to reduction of risk and uncertainty to both the borrower and the lender. The importance of such knowledge will greatly increase as technical innovation becomes an increasingly important aspect of agricultural credit. In view of this it may be necessary for the banks to give more attention to agricultural qualifications in the

19. For a typical example of a 'Budgeted Loan,' please see, "29th Annual Report of the Farm Credit Administration on the Work of the Co-operative Farm Credit System," 1961-62, Washington 25, D. C., 1963, p. 37.

20. C. R. Arnold: *Farmers Build Their Own Production Credit System* Organisation and First 25 years, 1933-58, Farm Credit Administration, Washington 25, D. C., 1958, pp. 57-58.

selection of their staff. These qualifications are necessary to intelligent analysis and are even more necessitated by the fact that successful programmes require that bank personnel be able to discuss recommendations intelligently with farmers, which will require a practical grasp of agriculture as well as a theoretical grasp.

A Farm Management Section may also be set-up in the Agricultural Credit Department of the Reserve Bank of India. It would be able to provide necessary advice and guidance in sanctioning farm loan accommodations and could conduct some useful research on related problems. This type of farm-oriented service and research will require that officers and other personnel serving in the Agricultural Credit Department of the Reserve Bank have a knowledge of the practical and technical aspects of agriculture. This orientation would also provide an improved basis for reports submitted on the inspections of various types of co-operative agricultural credit and marketing institutions and increase their usefulness.

ECONOMIC MODELS OF FARM PLANNING UNDER RISK AND UNCERTAINTY

JAI KRISHNA* AND D. K. DESAI**

Stability in farming is abnormal, change and the need to study and adjust to change are normal. Farm planning as an action programme is aimed at helping millions of farmers in India in decision-making so as to maximize production and income from the farm business. Farm management decisions relate to making changes in the :

- (a) crops and livestock enterprises on the farm—selection of a product-mix,
- (b) inputs used on the farm—selection on an input complex,
- (c) techniques of production—choice as to how to produce, and
- (d) marketing procedures—choice as to when, where and how to market farm products and purchase farm inputs.

Elements of Decision-Making

Components of a decision problem are sets of possible events, actions, strategies, and consequences, a criterion for ordering the consequences, and a function assigning a consequence to each pair consisting of an action and an

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