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Rapporteur's Report on Risk Management in Agriculture/Rural Sector

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I

INTRODUCTION

The management of risks has always been a live issue for the agricultural sector. The problems posed by droughts, floods, pests and disease have been with us forever. The power of these natural forces over agriculture, historically the primary source of wealth in all except small trading nations, has indelibly shaped the organisation of production, the forms of tax systems and hierarchies in society not to speak of belief systems and culture.

As productive capacity in agriculture has improved, and as incomes have risen, resources from agriculture moved to non-agriculture sectors to meet the demand for non-agricultural goods and services. This is the core process of economic development. The specialisation (into dual sectors) has to be facilitated by flow of food and other agricultural commodities. Although some developing countries tried to control and even nationalise these flows in the manner of the erstwhile Soviet Union, practical experience taught policymakers that the best mechanism to handle these mechanisms is still the market. But the market is not perfect. It does not necessarily allocate food to those most in need. Furthermore, markets are not predictable. How could small subsistence growers cope with this risk and produce for the market? Not only do market crashes cause economic distress to agriculture producers, they can also undermine the supply of inexpensive food that societies need to sustain their non-agricultural sectors.

Responses to these risks from nature and from the market have been varied. Anticipating the risks, growers have adopted strategies that can lower their exposure to risks or reduce the severity of adverse outcomes, if and when they occur. Some of these strategies such as the adoption of crops and crop varieties resistant to weather and pest risks, the liquidation and sale of assets and migration have been used for a long time.

Risks can also be shared. This is the principle of insurance. Long before formal systems of crop insurance were introduced, insurance arrangements in rural societies evolved through reciprocal arrangements and patron-client relationships. The latter could be seen in forms of land tenure such as sharecropping and in traditional

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dealings between a farmer and a merchant. In modern contexts, the risks are shared in contract farming arrangements and in commodity markets through futures contracts.

Modern day governments have also sought to institute policies and institutions to reduce risks. Price stabilisation programmes and crop insurance programmes are some of the examples. Irrigation development is another example where the goal is to reduce the vulnerability of agriculture to erratic rainfall. Government policies may also have unintended impacts on risks – these is particularly so in the international trade through the opening up of markets.

II

THE SCOPE FOR RESEARCH

Research on risk management can address a wide variety of issues. These issues can be classified in various ways. One distinction is between descriptive and analytical research. Within the analytical stream of research, work can be theoretical or empirical or both.

The object of descriptive research is to enlarge the factual basis of the subject. Examples of this are research studies which quantify different types of risks and risk attitudes, and which describe and enumerate the ex-ante and ex-post risk coping strategies.

The core of analytical research concerns the behavior of economic agents under risk. Examples here are research studies which look at the cost of risk on growers, evaluating the effectiveness of risk coping strategies, the determinants of the adoption of risk management strategies, the effect of risk on the organisation of production and marketing and the welfare implications of policies that affect risk.

The hallmark of analytical research is that it proceeds with an assumption or a model about how individuals make choices under risk. The dominant model in the economic literature has been the expected utility framework that is developed on the basis of an axiomatic characterisation of individual preferences. In the applied literature, special versions of this model, where expected utility is a function of the mean and variance of income (or profits), have been especially popular. In more recent times, alternative models of behaviour under risk have been proposed. These have the virtue of either being based on axioms less restrictive than the expected utility theory or of being more consistent with experimental evidence.

Research on risk management can also be classified according to the topic. Very broadly, research on risk management encompasses the following themes:

(a) Description and Quantification of Natural and Market Risks: It should be noted that not all risks are exogenous. The classic instance of this is the cobweb cycle of prices that results from backward looking forecasting behaviour of market participants.

(b) *Grower or Household Strategies to Reduce and/or Manage Risk*: A useful distinction can be made between risk reducing strategies that the farmer adopts *ex ante* and risk coping (or risk management) strategies that the farmer adopts *ex post* the shock. If a risk averse household is not able to achieve an entirely smooth consumption path through *ex post* mechanisms such as insurance, savings, and credit transactions, it has an incentive to devote resources *ex-ante* in an effort to secure a more stable income stream. In an agricultural economy, households might adopt technologies such as intercropping or drought- resistant crops, farm a diversified portfolio of land, and enter contractual arrangements such as sharecropping that reduce the variance of income, or diversify their activities through migration or local non-agricultural employment.

(c) *Mechanisms of Sharing Risk:* As mentioned earlier, community interactions and social customs could operate in a way to distribute risk amongst all members of a community. The mechanisms involved might be gifts, transfers or borrowing and lending. However, all mutual insurance schemes share the element of reciprocity. At the community level, exchanges and informal credit are the principal traditional risk coping strategies. A formal insurance market is another mechanism by which risks can be shared across agents more numerous than what traditional community would cover based on informal insurance arrangements. Here reciprocal relationships are replaced by formal contractual obligations that could in principle be enforced in a court of law. Such formal markets include crop and livestock insurance and also futures markets. Finally, risks can be shared in bilateral deals. An instance of this occurs in traditional arrangements between a grower and a trader (or commission agent) where the latter agrees to buy the grower's output at a fixed price in return for a part payment well in advance of the final transaction.

(d) *Government Policies and Risk Management:* Formal insurance markets are hindered by problems of imperfect information and costly enforcement. Government policies (by design or default) may then turn out to be substitutes for formal insurance. The leading examples of this kind are price support programmes and subsidised crop insurance programmes (that would otherwise not be viable and are therefore not offered by private insurers). In both these programmes, the risks of agricultural activity are shared with the government. The other kinds of government policies may affect risk management not so much by sharing of risks but by affecting the magnitude of risks. Examples of these are irrigation programmes and trade policies.

III

PAPERS AT THE CONFERENCE

Thirty-three papers were accepted for discussion. Most of the papers are descriptive which suggests that the risk management research in India is at the stage

of gathering stylised facts. The discussion below is organised by the principal topics that were covered by these papers.

Description of Risks, Coping Strategies and Risk Attitudes

Crop income risks result from price and production risks. An early study by Barah and Binswanger (1982) considered the relative importance of production and price risks in crop income risk where they used time series data (1956/57 to 1974/75) from 91 districts covering Andhra Pradesh, Karnataka, Madhya Pradesh and Tamil Nadu. Using the same methodology, Sumit Jain updates the Barah and Binswanger study to more recent periods. The paper by Krishan Kaushik *et al.* also aims at decomposing income risk into price and production risks. It uses time series data on lentil production from the Canadian province of Sasketchewan and employs a methodology different from that of Barah and Binswanger.

Parshuram Samal uses secondary data to estimate production losses from natural calamities (floods, drought and cyclones) in Orissa. The author also uses primary data to describe risk coping strategies of the farmers. Ex-ante methods rely on choice of rice varieties, area planted to rice and adjustments to crop management practices. Ex-post strategies rely on non-farm employment, *kharif* cropping patterns, consumption loans, migration and sale of assets. The paper by R.N. Barman is a similar effort. Using aggregate time series data on output for the North Bank Plains zone of Assam, the author ranks crops in the order of output variability. From primary data, the author finds that the most important coping strategy with the risk of floods is the choice of cropping system and rice varieties. Pawan Kumar *et al.,* also use time series data for the district of Mohindergarh in Haryana to estimate production variability for various crops. The paper by Lakshmi Dar Hatai surveys farmers and elicits their opinion on risk and risk management strategies.

Although it is often asserted that farmers are risk averse, rigorous evidence on this issue is hard to come by. In a pioneering study, Binswanger (1980), conducted experiments with individuals in rural India with real monetary pay-offs. In his experiment, Binswanger offered the subjects the choice of lotteries with different pay-offs. From the choices made by the subjects, it is possible to infer their risk aversion. From analysing the pattern of such choices, Binswanger found that most farmers in the sample were intermediate to moderately risk averse. As is expected, higher the stake, greater is the risk aversion. K.P.C. Rao and Kumar Charyulu revisit the same villages as in the Binswanger sample and conduct similar experiments. They also regress the risk aversion coefficients on a set of correlates but find the correlates to have low explanatory power.

Production Risks and Input Use

It is well known that risk averse farmers could also curtail the use of inputs that increase risk. Bliss and Stern (1982) take up this issue in investigating production choices in the village of Palanpur, in Uttar Pradesh. They find that fertiliser is a highly productive input in wheat cultivation, but the marginal product of fertiliser remains 3.5 times its price. Farmers could substantially raise the expected profits by increasing applications of fertiliser, but by using less fertiliser, investment losses are reduced in bad times. The authors' calculations suggest that the foregone expected profits are most plausibly explained by high levels of risk and risk aversion. In Antle's (1987) investigation of paddy producers in a village from the semi-arid regions of India, fertiliser was once again found to be a risk increasing input.

This theme is taken up by Archana Shukla. Using data on wheat and paddy production from Uttar Pradesh, she shows that the return from using fertiliser is highly stochastic and that the probability the return is negative is well above zero in some regions. Between the two crops, fertiliser use in wheat is less risky than that in paddy. Because of the short time-series data set, she relies on Monte-Carlo methods to simulate probability distributions. With a micro data set, however, the direct estimates of the relationship between volatility and input use can be made, for instance, using the Just-Pope specification of production functions.

Input use under risk is also the subject of the paper by R.B. Singh and Sunil Kumar Verma who use a MOTAD model to derive shadow prices of inputs. These shadow prices have the interpretation of marginal productivities. As expected, shadow prices increase with risk. The non-use of modern inputs is also the theme of the paper by Ramesh Prasad Adhikari. Here the author surveys a sample of farmers from the Morang district of Nepal to estimate the number of instances where improved varieties and fertilisers were not used due to risk.

Govind Pal examines the effect of training on production risks. He studies lac cultivation and compares a sample of trained growers with a sample of untrained growers and shows that although the trained growers report higher costs, they also receive higher net returns. It would have been useful to know if the variation in returns between growers was any different between the two groups.

Livestock and Fisheries

A welcome feature of this bunch of papers is that it contains two papers on livestock risks – a sector that is relatively under-researched relative to its importance in agricultural gross domestic product. The diseases of animals is the major risk in this sector.

The paper by Subhasis Mandal *et al.*, evaluates the economic gains from controlling gastro-intestinal parasite infections of cattle in Meghalaya. Using data from an experiment with varying treatments, the paper estimates the gain for each

treatment relative to no treatment. This is then extrapolated to the entire state using sample data on parasite infection during 2001/02 – 2004/05. This paper points to the high returns from disease control which then makes it important to understand the constraints that come in the way of wide adoption of disease control measures.

This is the subject of the paper by A. Suresh et al., who consider the determinants of the adoption of a vaccine against bovine diseases using data from a survey of livestock raising producers in Rajasthan. Only 18 per cent of sample growers report to have vaccinated their animals. Why? Is this because of lack of awareness about vaccination, or because of risk-taking behaviour or because of the cost of vaccination? Using logit regressions, the paper finds that vaccination is correlated with the size of operational holding, the value of fixed assets in livestock production, ownership of cross-breds and region dummies. Literacy, family size and the size of bovine holding were not important explanatory factors. It is not clear whether all of these variables are exogenous to the vaccination decision (especially ownership of cross-breds and the size of bovine holdings) and how that might affect the interpretation of results. Except for the region dummies, the regressions also exclude any variables that might be regarded as proxies for the supply of vaccination.

Through a series of case studies, S.L. Kumbhare and P. Selvaraj address the risks of entrepreneurship in the emerging sector of acquaculture in Himachal Pradesh. The paper highlights risks from poaching, lack of technical know-how and fish feed and policy uncertainty.

Pesticide Use and Pest Management

The paper by Alka Singh *et al.,* estimates the impact of integrated pest management (IPM) practices on pesticide use. They do this by comparing a sample of IPM trained and non-IPM growers. Even though the IPM trained growers do not follow all IPM practices, the study finds that IPM trained farmers use less pesticides in value and quantity. The study refines the comparison by also considering the properties of the active ingredient in relation to human health, animals, birds, acquatic species and beneficial insects. Many of these findings are also echoed in the study by K.S. Birari *et al.* who examine the impact of IPM on cotton growers in Maharashtra. By comparing samples of IPM adopters and non-adopters, they too find a reduction in pesticide use. They also find favourable effects on net returns.

P. Indira Devi *et al.,* propose an interesting hypothesis as a constraint to the adoption of IPM. They suggest that farmers perceive that IPM and natural pest controls will lead to a loss in yield. To examine this, the paper surveyed the adopters and non-adopters of IPM (including agricultural labourers) and the respondents were asked how much yields would decline because of natural pest controls and IPM. Expectedly, non- adopters estimate yield losses to be higher than adopters. The authors use regressions to determine the correlates of yield loss perceptions. Rather discouragingly, more educated and more experienced workers perceived higher yield

losses with IPM. On the other hand, the paper by Birari *et al.* that was cited earlier, does not find any reduction in yields associated with IPM. Devi *et al.* suggest that there could be an initial loss but IPM yields could eventually recover. If true, it would be important to verify this in order to design policies that are appropriate to this experience.

The environmental degradation due to chemical use is the subject of the paper by A.K. Vasisht *et al.* The authors calculate a biocide residue index based on the usage of each chemical, its toxicity index and half-life. The authors use a social planner approach to determine the optimal land use for the state of Haryana. The goal is to maximise foodgrain production and minimise biocide residue subject to natural resource constraints of land and water. In some scenarios, the constraints are also imposed on factor endowments. Interestingly, if foodgrain production was maximised without regard to the environmental objective, the resulting biocide residue is still within safe limits. However, the major constraints are natural resources especially water. Lowering biocide residue requires changes in land use.

Diversification and Cropping Pattern

D. Kumar Charyulu and K.P.C. Rao consider the determinants of diversification in rainfed areas of Andhra Pradesh using farmer level data set. They regress income on a bunch of variables including a diversification index to show that the diversification strategy results in a loss of income. The diversification index was in turn regressed on another set of variables. The most interesting finding is that participation in insurance reduces crop diversification – which is consistent with the risk diversification motivation. However, is participation in insurance exogenous to crop diversification?

Vinod Kumar *et al.* prepare risk efficient diversification plans for sample farmers from Himachal Pradesh using the MOTAD model. The portfolio of activities includes dairying. The authors find that activities such as dairying increase expected returns and decrease variability. This implies current activity patterns are either grossly inefficient or that the model does not consider all the risks associated with the new activities. The persistence of inefficiency is a puzzle and deserves further examination. The MOTAD model is also used by B.C. Bhowmick and C. Hazarika, who study diversification strategies in the face of risks from flooding.

Another study based on data from Himachal Pradesh is from T.R. Sharma and Dharam Paul. Their paper demonstrates the cost of diversification (of having to grow cereals) in the sense that farmers who grow more vegetables (rather than cereals) have higher incomes.

Crop Insurance

The history of crop insurance in India demonstrates that it has been expensive for the government without being attractive enough for growers. In this context, Prawin Arya *et al.* use time series district level data from Uttar Pradesh to evaluate a crop revenue insurance plan. They show that revenue insurance premium rates are lower than premium rates for yield insurance presumably because of negative correlation between prices and yields.

M.N. Waghmare *et al.* compare the growers with and without crop insurance in terms of cropping pattern, labour use, yields, and income. The growers with insurance use more inputs, have higher yields and higher income. The authors conclude that this is because of the risk reduction due to crop insurance. The paper does not however evaluate directly the contribution of insurance to risk reduction. That is a difficult undertaking and would require data over many years. S.B. Nahatkar *et al.* in a similar effort compare soybean growers with and without insurance. They point out that, because of the area yield design, there is no evidence of moral hazard among the insured farmers.

Contract Farming and the Marketing Chain

In some cash crops especially vegetables, the processors contract with growers to obtain supplies. In most cases, the grower supplies tools, land, labour and management while the processor supplies the grower with seed, other inputs such as pesticides and extension service. Usually, the contract specifies that the processor would buy all the produce at a pre-determined price. Cash crops such as vegetables are intensive in purchased inputs and subject to significant market risks. Indeed, for some of the vegetables grown on contract there might not be even an assured local market as would happen when they are grown for an export market. Without a contract, therefore, few growers would cultivate these crops with substantial market risks.

Contracting therefore provides a way in which producers transfer market risks to processors. In return, the processors receive assured supplies at a cost that might be lower than if they organised production themselves. In this exchange, both parties can in principle be better off. However, whether this actually happens is an empirical issue.

Sukhpal Singh offers a case study of contract farming in potato. He shows how the various contractual obligations could bear on the production and marketing risk borne by the producers. D.S. Navadkar *et al.* examine contract farming in poultry production. They compare a sample of contract growers with a sample of non-contract growers with respect to costs, returns and measures of production and price risk devised by them. Shrikant Kalamkar comprehensively reviews contract farming schemes in India outlining its advantages and limitations. The traditional potato

marketing chain with its build up of costs is analysed in Manish Kumar Singh and Ajeet Vikram's paper.

Futures Markets

A forward contract where a seller (or buyer) agrees to deliver (or accept) a commodity in the future at an agreed price is a way for commodity market participants to do away with price uncertainty. However, one of the parties might default at the time when the transaction is to be realised. Further, the forward contract is not easily tradable which the seller or buyer might desire if their circumstances change. Neither of these risks is present in futures contracts traded on futures markets. The clearing house in the futures market guarantees the contract and as the contracts are freely traded in the market, the market participants can exit from the contract at any point. There is, however, a basis risk that arises whenever the relationship of the futures price to the spot price changes. It is generally the case, however, that the basis (the difference between the current spot and futures price) is much more predictable than the spot commodity price. So futures trading involves the exchange of commodity price risk for a much smaller basis risk.

Jabir Ali and Kriti Bardhan Gupta compute the volatility in spot prices, futures prices and basis for several commodities traded at the National Commodity and Derivatives Exchange Limited. The paper also computes optimal hedge ratios and finds them to be close to one. N.S. Malik and Anupama Khatkar survey brokers and traders in futures exchanges. They list various factors that the respondents consider to be barriers to participation in futures markets. Their study highlights the lack of convergence of the basis to zero at contract maturity as evidence of the inefficiency of futures contracts in managing risk. S.R. Asokan and Anita Arya exposit how futures markets can be used for price risk management and construct a hypothetical example where an aggregator such a co-operative is able to hedge price risks on behalf of its members.

Price Supports

Sangeeta Shroff and Jayanti Kajale take up the question whether price supports have served to stem the downside risk from price variability. Their analysis relates to the major field crops in Maharashtra. Their data show that wholesale prices were above the minimum support prices for the period of the study and therefore the support mechanism was not used during this period. However, they note that the costs of production were by and large above the minimum support prices. The authors therefore suggest that the insurance cover would not have worked if prices had crashed. Shroff and Kajale use a broad notion of cost that includes variable costs, imputed costs of family labour and management input and the rental value of owned land. The question raised by this paper is whether the insurance cover of price

supports should be defined with respect to such an inclusive concept or a more limited notion of costs.

IV

CONCLUDING REMARKS

In conclusion, let us note some commonalities in the papers that are otherwise on disparate subjects. A remarkable feature of the papers under discussion is their predominantly empirical basis. There were no theoretical papers – whether on the design of insurance schemes, or on the transfer of risks during vertical integration or on the impacts of government policies on farm level risks and farmer welfare.

A large number of empirical papers used primary data. Secondary data on prices and output can rarely throw sufficient light on farm level risks and that probably prompted many of the researchers to collect their own data. A common methodology of estimating the impact of a programme (whether crop insurance, contracting, or IPM) was to randomly select a group of growers adopting the programme and compare them with another group not adopting the programme. While random selection is essential it does not always eliminate bias. This is because of the possibility that the group of adopter growers might have self-selected into a programme. Thus, for example, if the growers with insurance have higher incomes, it does not necessarily imply that insurance increases expected incomes through, say, greater adoption of risk reducing inputs. This is because it is possible that it is the growers with higher incomes who opt for insurance. Therefore, the authors could consider alternative estimation strategies (or sample selection strategies) that can better deal with such biases. A general sort of econometric issues which, by and large, has also been ignored is the possibility that some of the correlates are not exogenous to the dependent variable.

Many papers have evaluated optimum cropping patterns or some such optimal allocation of resources. These papers have noted that observed resource allocations rarely confirm to the optimal. It would be extremely revealing both for the model and for farmer behaviour to better understand the deviations from the optimum.

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