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RESEARCH NOTES

TESTS OF HEDGING EFFICIENCY*

Problems in Hedging Efficiency Analysis

Although for nearly a century last, futures markets all over the world have been used by different market functionaries for purposes of hedging, the evaluation of these markets in terms of their hedging efficiency has remained a formidable problem even till this day. The difficulties involved in any attempt at such analysis are many and complex. These arise because the practices and purposes of hedging differ from time to time as well as from hedger to hedger.

Theoretically, there is no gainsaying that the economic efficiency of any activity could be assessed with reference to its cost-benefit relationship. The optimum economic efficiency under perfect competition presupposes that the marginal return from a given activity is equal to its marginal cost at the least cost point on the average total cost curve. It is, however, not easy to apply this pure theoretical criterion for the measurement of hedging efficiency of a futures market, where the difficulties involved in estimating returns from hedging and costs thereof are numerous.

Businessmen use futures markets for manifold purposes. The economic returns of their hedges manifestly depend upon their objects and motivations. A given change in the relationship between the ready and futures prices may yield different returns to different types of hedgers. Likewise, the same hedger may obtain different returns from even identical price movements during different hedge periods, because his motivations for hedging may differ during different periods. Thus, the returns from a risk-avoidance hedge depend upon the extent to which the risk in the ready market is reduced or avoided. A five or fifty rupee rise or fall in the futures price yields the same economic return to a risk-avoidance hedger so long as the ready price also rises or falls by the same amount. But to an 'anticipatory' hedge-buyer having no forward commitments in the ready market, the greater is the rise in the futures price, the larger are his gains from hedges, and vice versa. The reverse is true for 'anticipatory' hedge-seller. Moreover, anticipatory hedge purchases of raw materials often enable a manufacturer to continue the process of manufacture uninterrupted without regard to any intermittent upsurge in the prices of such raw materials. This advantage often outweighs the direct monetary gain from changes in the ready and futures prices. It is, however, difficult to estimate the value of any such indirect benefit in precise pecuniary terms. A similar difficulty arises while estimating returns from

* This note has been drawn from one of the chapters of the author's Ph.D. dissertation: "Efficiency of Futures Trading in Oilseeds" which was completed under the guidance of Prof. M. L. Dantwala.

operational hedges which essentially simplify merchandising operations and facilitate quick decisions regarding purchases and sales to be effected in the cash market.

A further difficulty arises when not risk-avoidance but profit maximization, as suggested by Working, is the principal economic motivation for hedging. Hedges then yield different returns to their holders according as the hedgers are 'long' or 'short' in the futures market. The interests of these two classes of hedgers holding opposite commitments in futures markets necessarily conflict. While 'long' hedgers benefit from hedging when futures price rises more than the ready, the 'short' hedgers simultaneously tend to lose. On the other hand, when the futures price falls more than the ready, the 'short' hedgers gain, but the 'long' hedgers lose. Evidently, a futures market which is thus efficient for 'long' hedging is inefficient for 'short' hedging and vice versa.

This is not all. The 'net' returns from hedging depend upon not only the movements of ready and futures prices—in both their direction as well as magnitude—between the time when the hedge is placed and the time when the same is lifted, but also the nature and practices of hedging. A hedger might hedge in the futures market all or part of his commitments in the ready market. He may operate simultaneously in more than one futures market and also within the same market for futures contracts of more than one delivery month. He may transfer his hedge from futures contract of one delivery month to another, or from one market to another. In all such cases, his net gains or losses depend upon one or more of such multitude of factors like volume of commitments hedged, timings of placing and lifting of hedges in different markets and contracts of different delivery months, timings and rates at which hedges are transferred from one market to another or from futures contract of one delivery month to another, etc. In other words, often the actual gains from hedging depend more upon the personal skill of an individual operator than on the behaviour of the market prices.

Further, because of the diverse types of transactions entered into in the ready and futures markets, gains or losses from one type of transactions are usually supplemented or offset, in part or in whole, by those from other types of transactions. Moreover, for most business houses, transactions in the spot and futures markets are part of their larger ventures involving a variety of interests. Conceptually, it would not be always correct to isolate the returns from the former from those from the latter, and this makes the task of measurement of hedging efficiency still more intricate.

It is clear that even for evaluation of an approximate efficiency or effectiveness of hedging in a futures market, it is essential to know under what conditions and to what extent different types of transactions were entered into by hedgers in ready and futures markets and also to what extent they could supplement or offset their gains or losses from one type of transactions by those from others. Unless, such a detailed information is available for a large body of hedgers, a true assessment of hedging efficiency of a futures market could never be complete. Unfortunately, such information is always lacking and hence researchers have attempted to evaluate the utility of futures market for the purpose of hedging through generating a set of hypothetical hedges, placed and lifted under another set of hypothetical conditions.

Stability of Basis Test

Most tests employed by economists like Howell,[1] Watson,[2] Yamey[3] and Graf[4] have relied on parallelism of price movements between ready and futures markets for ensuring perfect hedging effectiveness. Generating a large set of hypothetical hedges of such uniform periods as 4 -, 8 - or 16-weeks, these economists measured the extent to which the gains or losses in the ready market of a commodity were offset by the corresponding losses or gains in its futures market. The tests essentially involved comparison of gains or losses from hedging with those without hedging.

These tests assume that hedging in futures market reduces price risks and is undertaken solely for that purpose. The tests therefore presuppose that for absolute effective hedging, ready and futures prices must always move together in both direction and magnitude. In other words, they all measured hedging efficiency in terms of what may be described as "basis" stability, *i.e.*, stability of the spread between the ready and futures prices. A hedge was regarded as ineffective to the extent to which the basis varied during the duration of the hedge.

One of the major drawbacks of these tests even for assessing risk-reduction efficiency of hedging, was the assumption that transaction costs as well a costs of storage are normally small, and, therefore, could be ignored in the 'net' profit or loss analysis of hedgers. Graf, in fact, argues that "incorporation of these data would only have served to complicate and not improve the analysis."[5] True, the transaction cost comprising brokerage and interest on margin and cover monies demanded by brokers are normally very small, but the same cannot be said about the cost of storage of physical goods. In fact, contrary to what Graf thinks, the omission of such carrying costs in any hedging efficiency test would not only impair its utility, but at times, may even prove fatal to the analysis.

1. L. D. Howell : Price Risks for Cotton and Cotton Products and Means of Reducing Them, Technical Bulletin No. 1119, United States Department of Agriculture, Washington D.C., July, 1955.
2. L. D. Howell and L. J. Watson : Relation of Spot Cotton Prices to Prices of Futures Contracts and Protection Afforded by Trading in Futures, Technical Bulletin No. 602, United States Department of Agriculture, Washington D.C., 1938.
3. B. S. Yamey, "An Investigation of Hedging on an Organized Produce Exchange," *Manchester School*, September, 1951, pp. 305-319.
4. T. F. Graf, "Hedging—How Effective Is It?," *Journal of Farm Economics*, Vol. 35, No. 3, August, 1953, pp. 398-413.
5. T. F. Graf, *op. cit.*, p. 400.

The carrying cost, it should be recognized, is the basic determinant of the nature and magnitude of the spread or basis between the ready and futures prices at any time. Usually, the variations in such basis are closely related to the variations in carrying charges. Both theoretically and empirically, the basis varies through time under the influence of carrying cost and *a priori* it is expected to disppear as the futures contract approaches its due date or maturity.

The stability of the basis is also neither logically necessary nor expected for an effective hedge which requires a reduction in the basis by an amount equal to the carrying cost actually incurred through the hedge period. This is because over any given period, the ready price of a commodity is normally expected to rise more (or fall less) than the futures price of it by the amount of carrying cost incurred during such period. For a truly effective hedge, this variation in the magnitude of price movements in the two markets is necessary as it enables the selling hedger (who buys or holds stocks and sells futures) to earn his carrying cost. Conversely, the buying hedger who avoids the holding of physical stocks by buying futures must obviously pay such cost. In other words, an effective hedge necessarily presupposes that if the relationship between the ready and the futures prices shows a positive basis (premium for futures over the ready), such basis shall narrow down during the hedge period by an amount equal to the carrying cost actually incurred by the hedge-seller, while, in the converse case, the negative basis (discount of futures under the ready) shall increase by the amount of such cost. If, however, the basis remains unchanged over the length of the hedge period, the hedge-seller loses by hedging whereas the hedge-buyer gains. In that event, the loss to the hedge-seller and the gain to the hedge-buyer would tend to be equal to the carrying cost which the former bears but fails to recover from the latter because of the basis stability.

A few illustrations would vividly reveal how the basis stability test that omits to take into account the carrying cost in its calculations of profits and losses from hedging and non-hedging may be not only inadequate but sometimes even misleading. Thus, suppose a hedge-seller buys and stores castorseed at Rs. 100 per 100 kg. and simultaneously sells the futures contract for equivalent quantity at Rs. 105. The hedge is lifted, say, after two months when the ready and futures prices are quoted at, say, Rs. 95 and Rs. 100 respectively. Here, since the basis has remained unchanged over the hedge period, the hedge would be deemed as cent per cent effective by the logic of the test of basis stability. But, if one were to take into account the cost of storage of castorseed for two months, it would at once be realised that the total loss of the hedge-seller has only been partially recovered from the gain in the transactions in the futures market. If the carrying costs for the period are, say, Rs. 5 per 100 kg., the hedger obviously suffers a total loss of Rs. 10 (Rs. 100—Rs. 95 + Rs. 5) in the ready market. Evidently, with the compensating gain of only Rs. 5 (Rs. 105—Rs. 100) in the futures market, the hedge is really effective to the tune of but 50 per cent.

Conversely, suppose the ready and futures prices are quoted at Rs. 104 and Rs. 109 respectively when the hedge is lifted. Here again, Yamey and others would have declared the hedge as wholly effective and therefore a perfect hedge. But, in fact, if the carrying costs are taken into consideration, the hedge-seller suffers a loss of Re. 1 (Rs. 100—Rs. 104+Rs. 5) in the ready transaction and a further loss of Rs. 4 (Rs. 105—Rs. 109) in the futures market. Thus, far from being a compensating hedge, the transaction in the futures market in this illustration has only aggravated the loss in the ready market. Obviously, contrary to the stability of basis test, this hedge deserves to be classified as wholly ineffective hedge. Thus, the basis stability test that ignores the carrying cost is both unreliable and misleading.

More lately, Yamey seems to have realised the desirability of improving the stability of basis test by making an adjustment therein for carrying cost. In a recent Addendum to the reprint of his previously published paper "An Investigation of Hedging on an Organized Produce Exchange," Yamey writes: "It may seem as if the stability-of-basis test could be improved by making an adjustment for carrying cost."[6] He, however, summarily dismisses the need for such a correction on the twin grounds of impracticability and relatively small relevant charges for the assumed eight-week hedge periods. Unfortunately, he has not adduced any evidence to show how small might be the carrying charges in different commodities relative to the price fluctuations in the ready markets thereof. In India, for oilseed commodities, storage costs for one month period are currently equal to about 2 per cent or even more of the prices of the respective commodities. For still longer storage periods, costs are proportionately larger. By no token, these costs could be regarded as small. With average over-the-month changes in oilseeds prices of not more than 5 to 7 per cent, there can be no doubt that the carrying costs significantly reduce profits from storage when prices rise, and increase losses therefrom when prices fall. Moreover, since unlike storage costs, price changes do not increase *pari passu* with the duration of the storage period, the importance of carrying cost in estimating profits or losses from storage tends to swell with the length of the hedge period.

Yamey's plea of impracticability of computing true carrying charges is still less convincing. No doubt, the calculation is not very easy, but it is also not impossible to estimate approximate carrying costs for any commodity for different periods, since warehouse rents and interest rates—the two major elements of such costs—are usually known. Besides, once it is recognized that without an appropriate correction, the results of a test are likely to be highly erroneous and misleading, the proper course is to reject the test itself

6. P. T. Bauer and B. S. Yamey: Markets, Market Control and Marketing Reform—Selected Papers, Widenfeld and Nicolson, London, 1968, p. 368.

if the desired correction is impracticable to implement, rather than to pursue such test without the necessary correction. In fact, however, it is practicable to improve the stability of basis test by making an adjustment therein for average or approximate carrying cost. True, insofar as such carrying costs are only approximate and not accurate, a margin of error may creep into the results of the analysis; but the error could obviously be much smaller in the presence of such an adjustment for the stability of basis test than in its absence.

Gray[7] had realised the fallacy of the stability of basis test. Unfortunately, the results of his statistical test to determine the 'expectational bias' of a futures market through assessing whether such a market provides a statistically significant profit (or loss) to a persistently short or long hedger are closely similar to (if not identical with) those of the stability of basis tests.[8]

Heifner's Techniques

More recently, Richard G. Heifner developed two techniques for measuring the effectiveness of futures trading for hedging. One he used for determining the extent to which hedges reduce price risks associated with storage,[9] while the other sought to measure the gains from what Holbrook Working calls "carrying charge" hedges.[10]

The test evolved by Heifner to evaluate the risk-reduction effect of hedging was in fact an improvement superimposed on the techniques earlier adopted by Yamey and others. He compared the average gains or losses from storage with complete hedging, with corresponding average gains or losses from storage without hedging. Thereafter, he calculated the standard deviation of each series of such gains or losses and regarded it as a measure of price risk. A higher standard deviation which obviously denotes more fluctuations in a series, represents higher risk and vice versa. A comparison between the standard deviation of storage gains from hedging with that of corresponding gains without hedging showed that for all commodities tested by Heifner, the former was invariably smaller than the latter. 'F' ratios were also computed to find out whether the underlying differences between the variance of gains from storage with hedging and the variance of corresponding gains without hedging were due to chance alone.

7. R. W. Gray, "The Importance of Hedging in Futures Trading ;" and "The Effectiveness of Futures Trading for Hedging," Futures Trading Seminar--History and Development, Vol. 1, Part 2, Mimir Publishers Inc., Wisconsin, 1960, p. 70.

8. For demonstration of similarity between the two tests, see R. H. Snape and B. S. Yamey, "Test of the Effectiveness of Hedging," *Journal of Political Economy*, Vol. LXXIII No. 5, October, 1965 pp. 540-544.

9. Richard G. Heifner, "The Effectiveness of Hedging as a Means of Reducing Risks Associated with Seasonal Grain Storage in Michigan," *Quarterly Bulletin of the Michigan Agricultural Experiment Station*, Michigan State University, East Lansing, Vol. 48, No. 4, May, 1966, pp. 538-546.

10. Richard G. Heifner, "The Gains from Basing Grain Storage Decisions on Cash-Future Spreads in Michigan," *Quarterly Bulletin of the Michigan Agricultural Experiment Station*, Michigan State University, East Lansing, Vol. 48, No. 4, May, 1966, pp. 547-558.

The second technique devised by Heifner seeks to test Working's hypothesis with respect to the carrying charge hedging. The carrying charge hedging presupposes that anticipating changes in relations between ready and futures prices is far simpler than anticipating changes in levels of ready prices. According to Working, a carrying charge hedger hedges his stocks in order to gain from storage through favourable change in the price relation between ready and futures markets. Working asserts that a favourable or an adverse change in such price relation could easily be spotted from the existing relation between ready and futures prices. Heifner employs least square regressions to determine whether cash-futures spreads could be used effectively to predict both cash price movements and the basis changes. His empirical results generally showed that the current price relations are better determinants for predicting basis changes than changes in the levels of cash prices.

Heifner's technique of evaluating the risk-reduction efficiency of futures trading takes into account interest charges on capital invested in the stored inventories for estimating net revenues from hedged and unhedged storage. He, however, does not make an allowance for any other storage cost. As such, the results of his analysis are subject to a margin of error, though such error may be much less than those in the pure stability of basis test.

An important analytical limitation of Heifner's test, however, is his reliance on statistical averages. Heifner's analysis involves statistical comparison between average gain (or loss) from hedging with such gain (or loss) without hedging. This aggregative technique no doubt informs a hedger whether, on an average, over a period, he could expect to gain from hedging as a long or a short. But it does not provide him with any information regarding the probable extent of gains and losses in individual hedging transactions, or even the likely frequencies of such profitable and unprofitable transactions. It also does not assist him in selecting either the contract months in which he could expect to operate more profitably or periods in which he could hedge and those which he should avoid. Only elaborate frequency distributions of individual hedging transactions by periods of their operations, by contract months, by size of gains and losses, etc., could offer more fruitful guidance as aforesaid to different classes of hedgers. Heifner's test therefore is less meaningful for fully assessing the utility and performance of any futures market for the purpose of hedging. After all, "the performance or characteristics of a market cannot be judged on the basis of one statistic alone."[11]

Heifner's use of standard deviation of the storage revenues as a measure of risk-reduction efficiency of futures market also seems to be of dubious practical utility. In fact, a low standard deviation of storage revenues with hedging is conceivable for those futures markets which yield persistent large losses

11. B. S. Yamey, "An Investigation of Hedging on an Organized Produce Exchange—Addendum," in P. T. Bauer and B. S. Yamey : Markets, Market Control and Marketing Reforms, *op. cit.*, p. 370.

to one class of hedgers. In other words, the technique of standard deviation fails to reveal the bias or lopsided character of the futures market which renders such market beneficial to one class of hedgers but harmful to others. A low standard deviation of income from hedged position vis-a-vis that from unhedged positions in such a situation, is a poor consolation to the class of hedgers against whom the market is biased.

Heifner's attempt at verifying Working's hypothesis—that it is easier to predict changes in the basis than to predict changes in the levels of ready prices—is, however, more convincing. It clearly establishes the utility of basing storage decisions on ready-futures price spreads. Nevertheless, it would be rash to conclude that all storage decisions of merchants are determined by considerations of only carrying charge hedging. Expectations of favourable changes in ready prices, availability of storage space, nature and extent of credit facilities, desire to remain in business or outwit the competitors and the existence of facilities near at hand for risk-avoidance hedging, are all important factors which also assist a merchant in his decision to store or not. Moreover, since the carrying charge hedging is only one kind of hedging—and not always an important one—from amongst the many listed by Working, it follows that a test which simply verifies its effectiveness to the exclusion of all other forms of edges, can hardly be characterized as adequate for analysing the utility of futures market as a medium for different types of hedging uses. Such a test can at best supplement other tests, but cannot really replace them.

Summing Up

To sum up, despite several heroic attempts at evolving tests of hedging efficiency, the problem of measuring the utility and performance of commodity futures market has still remained largely unresolved. Some of these tests, no doubt, can measure the approximate efficiency of stereotyped risk-reduction or carrying charge hedges. But a precise test or a set of tests which can assess the hedging efficiency of a futures market in all its dimensions is yet nowhere in sight.

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GREEN REVOLUTION AND CAPITAL AND CREDIT REQUIREMENTS OF THE FARMERS IN SEMI-ARID REGION OF RAJASTHAN*

Indian agriculture has undergone a rapid technological transformation during the last few years. Most of the inputs required for this technological transformation, *viz*, high-yielding variety seeds, fertilizers, insecticides and pesticides, electricity, improved implements and machinery are purchased

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from the non-farm sector. The increased use of these modern inputs has resulted in the increased capital needs of the farmers. The increased capital requirement cannot be met from the farmer's own fund as the pre-adoption incomes are barely sufficient to provide minimum necessities of life. Inadequate availability of capital has been identified as a major cause of low productivity and slow adoption of technology on a majority of Indian farms.[1,2] Inadequacy of credit to supplement own resources is one of the most important constraints on Indian farms.[3,4] It becomes impossible for the non-viable small farms to adopt and take advantage of the new technology.

A recent study conducted in Sangli district of Maharashtra shows that the adoption of new technology in the absence of provision of credit will reduce farm incomes by 21.65 per cent to 68.48 per cent on the small farms. However, with the availability of credit, the incomes can be increased by 22.34 per cent to 68.36 per cent.[5]

What potential does the new technology provide for the farmers in semi-arid region of Rajasthan ? How far will the provision of credit help in accelerating the rate of technological transformation in this region ? Would the effect of the new technology on the credit requirements be the same for all sized farms ? These are some of the questions which need immediate answer before any programme for improving the incomes of the farmers of this region can be undertaken. The present study was directed to answer these and some other related questions. Specifically, the objectives of the study are (*i*) to estimate the present capital needs and changes therein as a consequence of adoption of improved level of technology, (*ii*) to estimate the credit requirements at the present as well as at the improved level of technology, and (*iii*) to examine the seasonal pattern of credit needs by different sizes of farms.

METHODOLOGY

The semi-arid region[6] of Rajasthan comprises of seven districts. Jaipur district was purposively selected for the present study as this district represents the agro-climatic conditions of the region. There are 17 Panchayat Samities in the district. Jothwara Panchayat Samiti was selected for this study.

1. L. R. Singh, J. P. Bhati and S. L. Jain, "The Supply, Utilization and Economic Rationale of Credit Use on Progressive and Less Progressive Farms," *Indian Journal of Agricultural Economics*, Vol. XXVI, No. 4, October-December, 1971, pp. 474-479.
2. U. S. Singh and Dayanatha Jha, "A Normative Analysis of the Impact of Capital Availability on Farm Income and Demand for Short-term Credit on Farms in Delhi," *Indian Journal of Agricultural Economics*, October-December, 1971, pp. 524-532.
3. Harwant Singh and A.S. Kahlon, "A Study of Credit Requirements and Advances to Farmers in Patiala District," *Indian Journal of Agricultural Economics*, October-December, 1971, pp. 496-503.
4. J. S. Sharma and B. Prasad, "An Assessment of Production Credit Needs in Developing Agriculture," *Indian Journal of Agricultural Economics*, October-December, 1971, pp. 503-511.
5. K. K. S. Chauhan, S. Mundle, N. Mohanan and D. Jodha : Small Farmer Problems and Possibilities of Development, Indian Institute of Management, Ahmedabad, 1973, pp. 154-155.
6. Districts having average rainfall from 450 to 650 mm. per annum are categorized as semi-arid districts. These districts are Alwar, Jaipur, Bharatpur, Sawaimadhopur, Ajmer, Tonk and Bhilwara. A. K. Sen, "Agro-climatic Regions of Rajasthan," *Annals of Arid Zone*, Vol. 11, No. 1 and 2, March-June, 1972, pp. 31-40.

The amount of short-term loans advanced by commercial banks was highest in this area. State Bank of Bikaner and Jaipur has selected Jothwara and Machwa villages for intensive advance of credit under its potential credit advancement area scheme. These villages were, therefore, selected for this study.

A list of the farmers of these two villages was prepared. The farmers were, then, arranged in the ascending order of magnitude of their size of holding and were divided into three size-groups—small, medium and large. Twenty farmers from each size-group were selected on random basis. The data were collected through personal interview method with the help of a specially developed schedule. The study pertained to the agricultural year 1971-72. The data were pooled and averaged. A typical situation representing the average resource availability from each size-group was selected for detailed study.

Three optimum farm plans were developed for each of the three typical representative farms using the linear programming technique. The optimum farm plans were developed under the following situations.

Plan—P_1 : This is the present plan followed by the farmers. The main aim of analysing this plan was to know whether the farmers of the different size-groups have their own funds sufficient to meet the capital needed for the adoption of present as well as new technology.

Plan—P_2 : This plan represents the optimum cropping plan at the existing level of technology when the capital restriction is relaxed. The credit requirement of this plan compared with the previous plan (P_1) gives an estimate of additional credit which can be absorbed in the farm business by changing the crop mix so as to maximize the net return. This would reveal the impact of managerial input in farming on the farm credit needs.

Plan—P_3 : This plan represents the optimum plan at the improved level of technology with the provision of borrowing of necessary credit. This plan provides an estimate of optimum credit needs of the different size-class of farmers to adopt new technology. Plan P_3 compared with plan P_2 gives an estimate of additional credit required to switch over to new technology from the existing technology, whereas the comparison of plan P_3 with plan P_1 gives an estimate of credit requirement due to the change in both organization and technology.

Per acre capital requirements for different enterprises of *kharif* and *rabi* seasons were worked out. The items included in capital requirements are seed and manures (whether purchased or farm produced), fertilizers, irrigation (electricity charges), labour (permanent hired, casual labour and also the imputed value of family labour), insecticides and pesticides and the interest on the value of all the above costs for a crop season. The enterprise budgets were prepared separately at the existing and improved level of technology. The capital requirement at the existing level of technology includes the value of all inputs actually used by the farmers; whereas at the improved level of technology the inputs and their levels recommended by the Department of Agriculture for each crop of the area were considered.

While working out the credit requirements at the different levels of technology, present cash holdings (subsequently referred as cash owned) of the farmers were subtracted from the total capital requirement for the farm. Per acre capital and credit requirements were worked out by dividing the total per farm capital and credit requirements by the size of holdings.

RESULTS AND DISCUSSION

Optimum Farm Plans

Three plans for representative farms are presented in Table I. A comparison of plan P_1 and plan P_2 shows that the total cropped area has increased slightly on the small and large farms whereas on the medium size farm the cropped area decreased in both the season. This is due to resource restrictions other than capital. The area under bajra in the *kahrif* and wheat in the *rabi* season increased on all the farms. These crops are relatively more profitable compared to others. The cropping intensity increased on the small and large farms and decreased on the medium size farms.

The total cropped area has increased in plan P_3 on all the farms in the *kharif* season. The increase in acreage was maximum on the large farm. In the *rabi* season, the cropped acreage on the small and large farms remained almost the same but on the medium size farm the area increased. The cropping intensity also increased on all the farms. The increase in cropping intensity was maximum on the large farm (15 per cent) followed by the medium size (9 per cent) and small farms (4 per cent). The area under bajra in the *kharif* and wheat in the *rabi* season increased on all sizes of farms. This is due to the introduction of hybrid bajra and Mexican wheat in plan P_3. But the acreage under *guar*, maize, *moong* and lucerne decreased. The bajra crop substituted for *guar*, maize and *moong*. Barley and onion crops were substituted by wheat.

Capital Requirements

Per farm and per acre[7] capital requirements are presented in Table II. The capital requirements per farm increase in the optimum plans for all the farms. On an average, the capital requirement increases by 42.68 per cent in plan P_3 over plan P_1. Of this, 9.03 per cent increase is due to the change

7. The term per acre denotes per acre of operational holding.

TABLE I—OPTIMUM FARM PLANS FOR REPRESENTATIVE FARMS

(*acres*)

Crops grown	Small farm			Medium size farm			Large farm		
	Existing farm plan P_1	Optimum farm plan P_2 at existing level of technology	Optimum farm plan P_3 at improved level of technology	Existing farm plan P_1	Optimum farm plan P_2 at existing level of technology	Optimum farm plan P_3 at improved level of technology	Existing farm plan P_1	Optimum farm plan P_2 at existing level of technoloy	Optimum farm plan P_3 at improved level of technology
A. *Kharif season*									
Bajra	1·33	1·50	2·66	3·19	3·26	4·06	5·49	5·67	7·05
Guar	0·73	1·30	0·20	1·28	0·43	0·50	2·28	2·30	2·22
Moong	1·51	—	0·39	1·39	2·20	1·80	2·19	3·30	3·90
Cow pea	0·44	—	—	2·41	—	—	2·35	1·98	1·56
Maize	0·50	2·10	1·84	0·69	3·00	2·66	2·99	2·40	4·00
Total acreage in *kharif* season ..	4·51	4·90	5·09	8·96	8·89	9·02	15·30	15·65	18·73
B. *Rabi season*									
Wheat	2·00	2·50	3·00	3·33	4·80	3·50	3·70	5·60	6·75
Barley	1·21	—	—	3·46	2·56	4·10	5·09	6·03	4·69
Onion	0·31	0·20	0·24	1·49	0·11	0·23	1·39	0·55	0·67
Lucerne	0·33	1·20	0·66	0·89	0·59	1·20	1.89	1·88	1·89
Total acreage in *rabi* season ..	3·85	3·90	3·90	9·17	8·06	9·03	12·07	14·06	14·00
Total cropped acreage	8·36	8·80	8·99	18·13	16·95	18·05	27·37	29·71	32·73
Cropping intensity (per cent) ..	163·92	172·35	176·25	151·33	141·95	150·73	136·19	148·10	163·16

in the acreage under different crops at the existing level of technology while the increase due to change in technology is 30.86 per cent.

The increase in the overall capital requirements is highest on the small, followed by the medium size and large farms. Same trend in the increase in capital requirement is revealed when one moves from plan P_1 to P_2 and from plan P_2 to P_3. The small farms are more capital starved and their capital requirements increase more compared to the medium size and large farms.

The capital requirements are Rs. 2,113.50, Rs. 5,177.31, Rs. 8,237.17 on the small, medium and large size farms respectively for plan P_1. However, at the present resource level and existing technology, if one adopts the optimum plan (plan P_2) the capital requirements increase to Rs. 2,798.38, Rs. 5,524.60 and Rs. 8,608.35 on the small, medium size and large farms respectively. The change in enterprise mix or organization alone enhances the capital requirement on all farms. With the adoption of new technology (plan P_3), the capital requirement further increases to Rs. 4,461.60, Rs. 7,459.31 and Rs. 10,235.21 or by 59.43, 35.03 and 18.90 per cent on the small, medium size and large farms respectively, with an overall increase of 30.86 per cent.

The capital requirements were higher in the *rabi* season (compared to *kharif* season) by about 38 per cent at existing level (plan P_2) and by about 23 per cent at the improved level of technology (plan P_3). The irrigated *rabi* crops require more capital than the rain-fed *kharif* season crops.

The capital requirement per acre reveals a different picture than the total capital requirement. The capital requirement per acre was highest on the small farms and decreased with the increase in farm size. The increase in capital requirement on per acre basis with the change in enterprise mix at the present level of technology is Rs. 134.30, Rs. 28.99 and Rs. 18.51 on the small, medium size and large farms respectively. The increase in per acre capital requirements due to change in technology is much higher, *i.e.*, Rs. 326.12, Rs. 161.49 and Rs. 81.09 on the small, medium and large farms respectively. The change in capital requirement with the change in organization as well as technology was highest on the small farm and was lowest on the large farm. This is an indication of the fact that the present level of use of inputs on the large farms is higher than the small and medium size farms. On an average, the farmers in the study area need Rs. 456 per acre at the existing level and Rs. 600 per acre at the improved level of technology. Of this amount, approximately 55 to 60 per cent is required in the *rabi season.*

Credit Requirements

The credit requirements are presented in Table III. The credit requirement increases by 108.11 per cent in farm plan P_2 over the present plan P_1 on the small farm. However, on the medium size and large farms

TABLE II—CAPITAL REQUIREMENTS FOR THE OPTIMUM FARM PLANS ON THE TYPICAL SELECTED FARM SITUATIONS

(*Rupees*)

Size-group	Optimum farm plans	*Kharif* season		*Rabi* season		Total per annum		Percentage change in capital requirement in successive plans	Percentage change in capital requirement in plan P_3 over plan P_1
		Per farm	Per acre	Per farm	Per acre	Per farm	Per acre		
Small (5·10 acres)	P_1	722·90	141·74	1,390·60	272·66	2,113·50	414·40	32·45	
	P_2	1,037·78	203·48	1,760·60	345·21	2,798·38	548·70		111·10
	P_3	1,811·00	355·09	2,650·60	519·72	4,461·60	874·82	59·43	
Medium (11·98 acres)	P_1	1,874·45	156·46	3,302·86	275·70	5,177·31	432·16	6·70	
	P_2	2,043·60	170·58	3,481·00	290·66	5,524·60	461·15		44·08
	P_3	3,333·40	278·24	4,125·91	344·40	7,459·31	622·64	35·03	
Large (20·06 acres)	P_1	3,784·61	188·66	4,452·56	221·96	8,237·17	410·62	4·50	
	P_2	4,010·70	199·93	4,597·65	229·19	8,608·35	429·13		23·76
	P_3	4,787·40	238·69	5,447·81	271·57	10,235·21	510·22	18·90	
Overall average (12·38 acres) ..	P_1	2,127·32	171·82	3,048·67	246·27	5,175·99	418·09	9·03	
	P_2	2,364·02	190·96	3,279·75	264·92	5,643·77	455·88		42·68
	P_3	3,310·60	267·41	4,074·77	329·95	7,385·37	597·36	30·86	

TABLE III—SHORT-TERM CREDIT REQUIREMENT FOR THE OPTIMUM FARM PLANS ON THE TYPICAL SELECTED FARM SITUATIONS

(*Rupees*)

Size-group	Optimum farm plans	*Kharif* season		*Rabi* season		Total per annum		Percentage change in credit requirement in successive plans	Percentage change in credit requirement in plan P_3 over plan P_1
		Per farm	Per acre	Per farm	Per acre	Per farm	Per acre		
Small (5·10 acres)	P_1	202·90	39·78	430·60	84·43	633·50	124·21	108·11	
	P_2	517·78	101·52	800·60	156·98	1,318·38	258·50		370·65
	P_3	1,291·00	253·13	1,690·60	331·49	2,981·60	584·62	126·18	
Medium (11·98 acres)	P_1	724·45	60·47	1,862·86	155·49	2,587·31	215·96	13·42	
	P_2	893·60	74·60	2,041·00	170·37	2,934·60	244·94		88·20
	P_3	2,183·40	182·25	2,685·91	224·19	4,869·31	406·45	65·89	
Large (20·06 acres)	P_1	1,984·61	98·93	2,392·56	119·27	4,377·17	218·20	8·48	
	P_2	2,210·70	110·20	2,537·65	121·51	4,748·35	236·70		44·90
	P_3	2,497·40	146·92	3,387·81	168·88	6,335·21	315·81	33·40	
Overall average (12·38 acres)	P_1	970·65	78·40	1,562·01	126·17	2,532·66	204·57	19·52	
	P_2	1,207·36	97·62	1,819·75	146·98	3,027·11	244·50		86·69
	P_3	2,140·60	172·90	2,588·11	209·05	4,728·71	381·95	56·20	

the increase is only 13.42 and 8.48 per cent. The percentage increase in the credit requirements with the change in technology is 126.18, 65.89 and 33.40 respectively. The introduction of high-yielding varieties on the farm leads to substantial increase in the credit requirement in both the seasons. The percentage increase is 141.61, 144.33 and 33.32 on the small, medium and large size farms in the *kharif* season as against of 111.24, 24.63 and 23.57 per cent in the *rabi* season. The overall credit requirement per farm increases by 19.52 per cent when one moves from plan P_1 to P_2 and by 56.20 per cent when one moves from plan P_2 to P_3.

Per acre credit requirements are Rs. 124, Rs. 216 and Rs. 218 for the present farm plan (P_1) and increase to Rs. 258, Rs. 245 and Rs. 237 in farm plan P_2 on the small, medium and large size farms respectively. With the introduction of new technology per acre credit requirements further increase to Rs. 585, Rs. 406 and Rs. 316 on the small, medium and large size farms respectively. The level of use of fertilizers, insecticides and pesticides is much higher in plan P_2 on the large farm than on the medium and small farms.

Per acre credit requirement is higher in the *rabi* compared to the *kharif* season on all sizes of farms. By their very nature, *rabi* season irrigated crops require high level of inputs compared to the *kharif* season rain-fed crops.

CONCLUSIONS AND POLICY IMPLICATIONS

As farmers become oriented towards profit maximization, there would be a tendency to move from plan P_1 towards P_2 in the absence of technology and from P_1 to P_3 if technological changes are brought about simultaneously. The organizational as well as technological changes would significantly increase the capital and credit requirements on all farms. The credit needs of the farmers are expected to increase further with the change in technology. Therefore, efforts have to be made by the lending institutional agencies to extend credit facilities to the farmers based on their crop plans in order that the rate of adoption of new technology is not impeded. Further, the small farmers should be given particular attention in advancement of credit as they are more capital starved so that the fruits of improved technology are harvested by all the sections of the farming community.

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AN ECONOMIC APPRAISAL OF THE PATTERN OF HARVESTING COCONUTS IN BANGLADESH†

Coconut industry in Bangladesh is relatively a minor enterprise producing only about 128 million nuts annually on about 59 thousand acres of land. The coastal districts are the major producing areas accounting for about 83 per cent of the nation's total production. The extended coastal region in the country has a vast potential for its increased cultivation and production. The important peculiarity of this industry is that both mature and immature coconuts are commercially produced and marketed in the country. A large quantity of green tender nuts (locally known as *dab*) is used as sweet drink for refreshment purposes by people and for dietary purposes by the patients. Nearly half of the mature nuts (locally known as *narikel*) are believed to be consumed as fruits and ingredients in various food preparations. The rest of the mature nuts produced in the country are used for the production of coconut oil which is almost exclusively used here as hair oil and as raw material for production of various cosmetics. On the other hand, the country needs to import a huge quantity of coconut oil costing at least Taka 11.5 million[1] each year mainly for cosmetic purposes (2).‡ An additional 25 million[2] coconuts may be required to meet this deficit of coconut oil in the country.

In about 4 months after fertilization, the nuts possess the largest amount of 'nut water' inside the young shell. This water is a sweet refreshing liquid. This is the *dab* stage when the green nuts are used as drinks. It takes a total of 12 months, after fertilization, for a nut to mature fully. This is the *narikel* stage when the nuts are consumed as fruits or used for copra and oil production (3). A mature coconut contains 30.73 per cent kernel which contains 3 per cent protein and 30 per cent oil (1, 4, 5).

The biological characteristics of the products *dab* and *narikel* suggest that the two products can be produced either in different coconut trees or on the same tree. If these are produced on the same tree then it may mean that the two products are primarily the outcome of certain pattern of harvesting nuts from coconut trees. It is in this sense that the term 'pattern of harvesting coconuts' has been used in this study.

Results of the Investigation

In the coastal districts of Bangladesh farmers grow coconut trees mostly on homesteads. Organized cultivation of coconut on crop land is hardly done. Coconut trees are mostly scattered and unorganized. Traditionally,

† This paper is based on the author's work on Income Effects of the Prevailing Pattern of Coconut Harvesting in Bangladesh, Research Report No. 1, Department of Co-operation and Marketing, Bangladesh Agricultural University, Mymensingh, 1972.

1. Average of imports during 1960-61 to 1968-69, minus the average of coconut exports to West Pakistan (Pakistan) during 1964 to 1970.

2. Assuming that approximately 10,000 coconuts produce 1 short ton of coconut oil at the rate of 3·3658 ounces of oil per coconut.

‡ Figures in brackets refer to the literature cited at the end.

the growers harvest both the green nuts (*dab*) and the mature nuts (*narikel*)—the two competitive products—from the same tree. They do not exclusively produce green nuts on some trees and exclusively mature nuts on some other trees.

Both *dab* and *narikel* are harvested all the year round. But the major harvesting seasons are from February to June for *dab* and from May to October for *narikel*. On an average, an estimated 627 *dabs* and 1,124 *narikels* were harvested by each grower from 46 fruit bearing trees during the 1969 crop year.

Under the prevailing harvesting pattern, therefore, *dab* and *narikel* are produced at the rate of 36 and 64 per cent respectively in the major coconut growing areas. The rate of harvesting green coconut is 30 per cent in the Latin American countries where also coconut industry is a minor enterprise (6, Table 18). Production of *dab* and *narikel* together was 37 nuts per tree. But no conclusive evidence is available as to the nature of yield per tree if *dab* and *narikel* are harvested from the same tree at a varying proportion, or if exclusively one product is produced on the tree. The results of an observational study in Coconut Research Station, Rahmatpur, Barisal, Bangladesh, however, indicate that the yield per tree may be 99 nuts when exclusively green nuts (*dab*) are produced on the tree, that is, when the nuts are harvested as soon as these attain *dab* stage; and the yield may be 29 nuts per tree when exclusively mature nuts (*narikel*) are produced on the tree, that is, the nuts are harvested only when these attain full maturity. The results are, of course, not conclusive and reliable because there were many uncontrolled factors in that study.

On the other hand, the coconut growers do not clearly know what the yield per tree would be if exclusively one product is produced on the tree. They, of course, conventionally believe that, according to prevailing pattern of harvesting, if nuts from a tree are partially harvested in green stage as *dab* and partially harvested in full maturity stage as *narikel* the tree, because of thinning effect, gives better yield both in respect of size and total number of nuts. In the absence of their experiences about the nature of yield under different harvesting pattern, the growers were requested to make intuitive guesses or estimates about the yield per tree if exclusively *dab* or *narikel* was harvested from the tree. Accordingly they estimated that if exclusively *dab* was harvested the tree would yield 58 nuts, and if exclusively *narikel* was harvested the tree would yield 43 nuts annually (Table I).

Economic Implications

If the results of the observational study at the Coconut Research Station, Barisal, is considered as indications of the actual yield pattern of *dab* and *narikel* in the country, it would appear that at 1969 prices of *dab* and *narikel*

TABLE I—ESTIMATES BASED ON SURVEY DATA ON SOME ASPECTS OF COCONUT INDUSTRY IN THE COASTAL DISTRICTS OF BANGLADESH : 1969 CROP YEAR

Description	Green coconut (*dab*)	Mature coconut (*narikel*)	Coconut palms
(*a*) Production of nuts per tree when only one product is produced on the tree (No.)	58	43	
(*b*) Maximum production of nuts per tree when only one product is produced on the tree (No.)	79	56	
(*c*) Average price received by growers when sold at home (Taka per 100 nuts)	14.24	23.91	
(*d*) Average price received by growers when sold at local 'huts' (Taka per 100 nuts)	22.19	31.81	
(*e*) Maximum price received by growers (Taka per 100 nuts)	27.28	49.93	
(*f*) Trees owned by each grower (No.)			57
(*g*) Fruit bearing trees per grower (No.)			46
(*h*) Per cent of growers selling nuts :			
On farm	23	17	
At local 'hut'	77	83	

at farm level and primary market level a grower is better off if he produces *dab* instead of *narikel* on his trees. Some local experts believe that the yield of *dab* will be at least twice the yield of *narikel*, that is, by forgoing the production of one *narikel* two *dab* can be produced. Under the circumstances, therefore, a producer lost at least about 13.5 paisa[3] per *narikel* produced for sale during 1969 crop year.

However, based on the conception of the coconut growers on the yield pattern of *dab* and *narikel* it appears that the production of one *dab* can be traded off or replaced by the production of 43/58 *narikel*. If this ratio holds true for all possible patterns of harvesting nuts—combinations of *dab* and *narikel*—from the tree it will mean that at 1969 farm and primary market

3. From Table I it may be seen that most growers sold their nuts at local 'huts'. They received @ 22 paisa per *dab* and @ 32 paisa per *narikel*.

Production period is 4 months for *dab* and 12 months for *narikel* after fertilization. Therefore, one-third of the total revenue from *dab* during the year comes after 4 months, another one-third comes after 8 months, and the other one-third comes after 12 months. In the case of coconut, on the other hand, the total revenue for the year comes after 12 months. Therefore, under cash flow concept the producer of *dab* gets some additional benefits of interest during 12 months. Thus the total revenue from *dab*, in real sense, for comparison will be :

Sale price 22 × 2 =	44 paisa
Interest from cash flow effect	1.5 paisa
Total revenue	45.5 paisa

Accounting of interest under cash flow concept :

$$\frac{22 \times 2}{3} = \frac{44}{3} = 15 \text{ paisa}$$

Interest for 15 paisa for 8 months @ 10 per cent per annum ..	1 paisa
Interest for 15 paisa for 4 months @ 10 per cent per annum ..	0.5 paisa
Total ..	1.5 paisa

prices an individual grower could have earned at least 1 paisa[4] more per *dab* harvested for sale if he would have allowed the nuts (the nuts harvested as *dab* for sale) to mature fully and sold them as *nárikel.*

Therefore, the fact that *narikel* constitutes 64 per cent of the growers' total production of *dab* and *narikel* and 67 per cent of the growers' total marketed surplus of *dab* and *narikel* indicates that the coconut growers in the country are economically conscious and attempt to maximize their total revenue by producing and marketing proportionately more *narikel* than *dab.* Moreover, it is revealed that they are sufficiently price conscious and try to get the best possible price for their products. Most of the growers sell their nuts at the local market centres where the prices are higher than on the farm. This is more pronounced in the case of marketing *narikel* which is the higher priced and the main crop of the growers.

In terms of food values and industrial uses the nuts consumed as drinks are largely considered as economic misuse and wastage of the national scarce resources, because the 'nut water' has rather low nutritional values, the immature husks and shells are unusable and largely wasted. As a result the nutritionists and the industrial scientists criticise the production and marketing of *dab* in the country. The defenders often argue that the bad pecuniary condition of the coconut growers is the primary cause of production of *dab.* Due to bad pecuniary conditions the growers lack power to hold the nuts on the tree till their full maturity; as a result they have to harvest and sell *dab* in order to meet their day to day financial requirements.

The analysis leads to the conclusion that coconut growers in the country are primarily economic units; they are guided by economic motives; their behaviour and production decisions are consistently influenced by economic considerations towards maximization of benefits.

Policy Implications

The study suggests that any change in the production or harvesting pattern of coconut in the country has to be brought about through economic incentives to the growers.

A price support programme with a high enough guaranteed price to the growers of *narikel* may be required as a national policy for reducing the production of *dab* and thereby increasing the production of *narikel.*

4. At farm prices:	*dab*	14.00 paisa
	Interest from cash flow benefit	0·47 paisa
	Total	14·47 paisa
	narikel 43/58 × 24	18·00 paisa
At local market prices:	*dab*	22·00 paisa
	Interest from cash flow benefit	0·73 paisa
	Total	22·73 paisa
	narikel 43/58 × 32	23·72 paisa

The knowledge of actual yield ratios between *dab* and *narikel* under different harvesting patterns is essential for establishing effective level(s) of support or guaranteed price(s).

However, before deciding on the extent and level of reduction of *dab* production and consumption in the country, considerations must also be given to the medical value of *dab* as an easily digestible pure soft diet for the patients in the country, and its subjective value as a source of pure drink for entertainment and refreshment purposes particularly in the coastal areas where drinking water is salty and no comparable substitutes like cold beverages are commonly available.

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