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SUGARCANE AREA RESPONSE IN THE MILL ZONES OF BANGLADESH, 1947/48–1981/82

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I. INTRODUCTION

THE objectives of the present study are (a) to identify the factors responsible for variations in sugarcane area in the mill zones of Bangladesh during the period of 1947–81; (b) to estimate the short- and long-run elasticities of sugarcane area with respect to these factors; and (c) to examine the responses of sugarcane growers to price and yield risks. As discussed later, estimates of sugarcane elasticities are useful for policymakers in Bangladesh.

Sugarcane is the second most important cash crop after jute to the farmers of Bangladesh. However, its importance was increasing relative to jute over the period in question. In 1973/74, sugarcane accounted for 2.92 per cent of the total value-added figure for the agricultural sector at current prices, while jute accounted for 4.14 per cent; in 1979/80, sugarcane and jute contributed 3.28 per cent and 3.75 per cent respectively to the total value added generated by the agricultural sector [7].

The cultivation of sugarcane in the mill zones of Bangladesh can be traced back to early times. In Bengal (now divided into Bangladesh and the State of West Bengal of India), the sugar industry was developed initially as a small cottage industry producing non-centrifugal brown or yellow sugar (known as *gur*), and by the eighteenth century it had developed into a sizable export industry [2]. While in the first half of the nineteenth century the Indian sugar industry enjoyed an extended export market, during the latter half of that century India as well as Bengal turned into net importers of sugar due to Britain's discriminatory import duty policy [3]. The passing of the India's Sugar Industry Protection Act in 1932 gave the Indian sugar industry full protection from foreign competitors. This led to a large-scale expansion of modern sugar plants and an expansion of the area given over to sugarcane cultivation. The number of factories in India increased to 141 in 1942/43 from 130 in 1934/35. However, expansion in the sugar industry of Bengal was modest due to a pessimistic view of the Indian government regarding the prospects of Bengal's sugar industry [13]. This pessimistic view was expressed in the reports of the Indian Industrial Commission [23] and the

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Indian Sugar Committee [24]. Despite the neglect of the government, the first modern sugar factory was established in Bengal in 1933 and that number rose to 18 in 1940 [22]. The Bengal Chamber of Commerce ascribed the development of the sugar industry in the region over this period to the catastrophic fall in the price of jute, which is the main competitor to sugarcane [13].

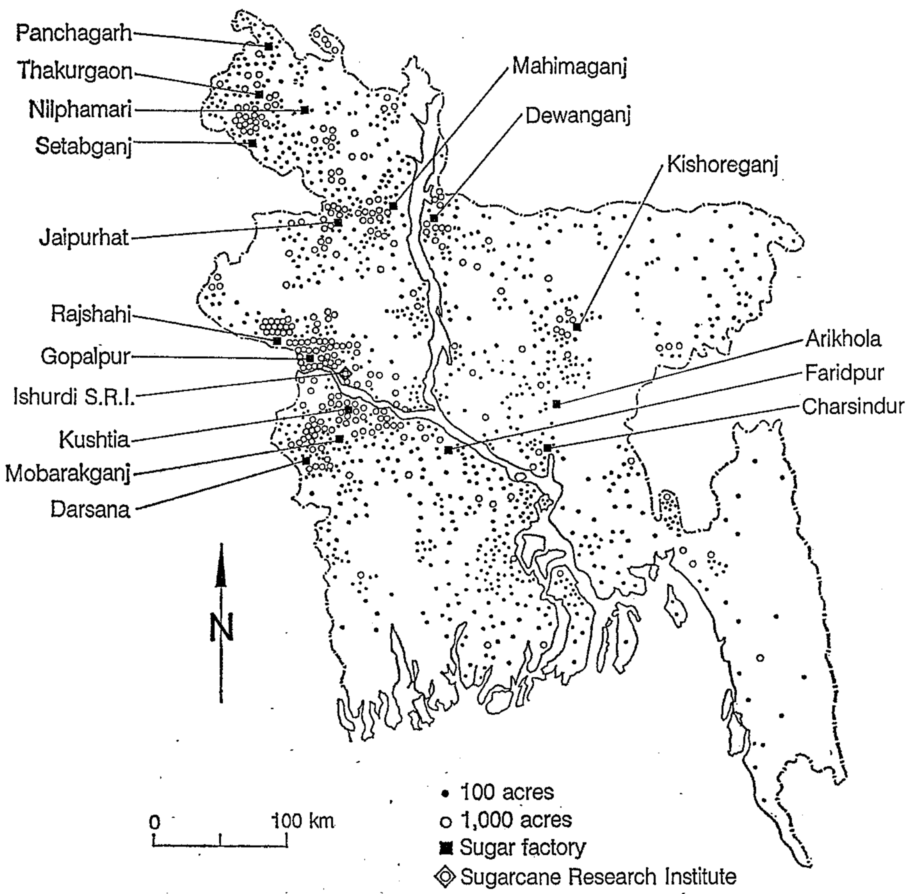
At the time of partition from India in 1947, Bangladesh (then East Pakistan) took over five sugar mills. The area and production of sugarcane increased sharply from 1947 in response to a sharp rise in the price of *gur* caused by supply shortages and to the government's policy regarding the sugar industry aimed at self-sufficiency in the production of sugar to conserve foreign exchange. Ten new mills were established by the government between 1957/58 and 1970/71 and placed under the ownership of the East Pakistan Industrial Development Corporation. In 1951, the government established the Sugarcane Research Institute at Ishurdi. By 1970, there were fifteen sugar mills with a total production capacity of 171,712 tonnes of plantation white sugar [36].

After independence from Pakistan in 1971, the Bangladesh government nationalized all sugar mills on July 1, 1972 and put them under the management of the Bangladesh Sugar Mills Corporation. In 1976/77 a new mill was established, and total production capacity of all mills rose to 181,672 tonnes [11]. Since independence, there has been no significant change in government policy regarding the sugar industry. The objective of the government is still to attain self-sufficiency in the production of sugar so as to conserve foreign exchange.

Although sugarcane is produced all over Bangladesh, the present study does not deal with all sugarcane growers. As has been mentioned at the outset, the objective of the current study is to analyze variations in sugarcane area in the mill zones only. These mill zones comprise areas from which sugar mills purchase their chief raw material, sugarcane. These zones are essentially dispersed around the locations of the sugar mills. The size of these zones vary from sugar mill to sugar mill. The size of a particular mill zone depends on the transportation network serving its sugar mill. On the average, a mill purchases its required sugarcane from areas lying within the radius of twenty to twenty-five miles. Figure 1 gives the approximate locations of the sugar mills and, hopefully, some idea of where mill zones lie.

The sugarcane market in the mill zones is segregated from other markets by various practices relating to sale/purchase transactions. First, the mills purchase sugarcane only from registered growers, who have been issued permits to sell the crop to them. Unregistered sugarcane growers outside the mill areas are not able to sell their crops to the sugar mills, but rather use them for *gur* production. Second, growers in the mill areas are not allowed to sell their sugarcane to any one else but the mills. However, the sugarcane growers can vary their area of cultivation depending on the relative profitability of the crop. Although a number of other crops including jute can be grown on land suitable for growing sugarcane, it is assumed that jute is the main competitor to sugarcane for land. This is because both are major cash crops and they can be grown on almost the same kind of land. The same view was expressed in the report of the Bengal Chamber of Commerce [13].

Fig. 1. Approximate Location of Cane Production, Sugar Mills, and Sugarcane Research Institute, Bangladesh

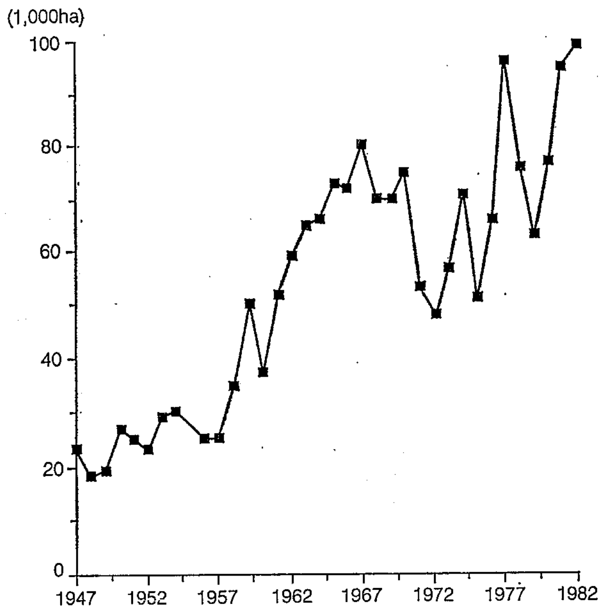


Source: [3].

Sugarcane being the major raw material for sugar production, the performance of the sugar mills in terms of whether their capital stocks are being fully utilized depends mainly on the availability or supply of sugarcane to them. It was observed by the Planning Commission in 1980 [10] that the sugar mills in Bangladesh up to that point had never achieved their full production potentials except in 1977/78.[1]

[1] Adequate supplies of sugarcane helped the sugar mills to achieve their full production potentials in 1977/78 production year. The area planted with sugarcane increased by about 46 per cent in 1976/77 plantation season over the previous plantation season. This increase in sugarcane area led to an adequate supply of raw material to the mills in 1977/78. The dramatic increase in sugarcane area was mainly caused by a 20 per cent increase in the purchasing price of sugarcane over the previous year. Moreover, favorable climatic conditions permitted all sugarcane planted to be harvested by the growers.

Fig. 2. Sugarcane Area in the Mill Zones of Bangladesh, 1947/48 to 1981/82



Sugar mill managers and researchers blame this on the inadequate and uncertain supply of sugarcane to the mills. It is observed that over the period of 1947–81 the area devoted to sugarcane in the mill zones showed great fluctuations around a positive trend [26]. That is, although sugarcane area showed an upward trend over this period, the trend was marred by short-run fluctuations. Figure 2 substantiates this phenomenon.

Various measures have been taken by the government and mill authorities to maintain an adequate and stable supply of sugarcane to the mills, some of which have been even coercive in nature. First, a government order, known as the 1956 East Pakistan Government Gur, Sugar and Sugar Product Control Order, was passed, under which sugarcane growers in the mill zones were prohibited from using their crop for *gur* production. However, this measure is oppressive in nature as some studies show (e.g., [3]) since *gur* production is more profitable to the growers than selling the crop to the sugar mills. Second, the price of sugarcane, which is determined by the government, is increased by the government from time to time to induce the farmers to grow more sugarcane. Also, they are given the opportunity to buy sugar directly from the mills at a price much lower than the market price. Third, the sugarcane growers are offered credit at a lower than market rate of interest to buy "seed cane," fertilizers, insecticides, labor, etc. The sugar mills also provide extension services. Fourth, a sugarcane research institute has been established to develop and offer high-yielding varieties of sugarcane and other services to the growers.

The following discussion is organized in the following way. In Section II, the models used to explain variations in sugarcane area are described. In Section III, the data and its sources are discussed. In Section IV, the results obtained from the models are reported and the best model is chosen on the basis of statistical and economic criteria. An economic interpretation of the results from the best model are given in Section V. Finally, in Section VI some conclusions are drawn.

II. MODELS OF SUGARCANE AREA RESPONSE

An examination done by Jaforullah [26] of economic theory pertaining to the supply of agricultural crops and a review of literature on estimation of supply responses of sugarcane suggest that the following long-run model can be used to explain variations in sugarcane area in the mill zones of Bangladesh:

$$SAREA_t^* = \alpha_0 + \alpha_1 RPR_t^* + \alpha_2 RYLD_t^* + \alpha_3 RPRR_t + \alpha_4 RYLDR_t + \alpha_5 DM_t + \alpha_6 DB_t + u_t, \quad (1)$$

where

$SAREA_t^*$ = "desired" planted area of sugarcane in thousand hectares in period t,

RPR_t^* = expected "normal" farmers' price of sugarcane (taka/tonne) relative to that of jute in period t,

$RYLD_t^*$ = expected yield of sugarcane per hectare (in tonne) relative to that of jute in period t,

$RPRR_t$ = relative price risk of sugarcane to jute in period t,

$RYLDR_t$ = relative yield risk of sugarcane to jute in period t,

DM_t = dummy variable representing the opening of one or more new sugar mills in period t,

DB_t = dummy variable representing the ban on *gur* production,

u_t = disturbance term, and

α_i = ith parameter, where $i = 1, 2, \ldots, 6$.

In this specification of the sugarcane area response model, jute is considered as the competing crop. This is because both crops, sugarcane and jute, can be grown on the same type of land and, being major cash crops, they meet the cash requirements of the farmers of Bangladesh. The view that jute competes with sugarcane for land and nonland resources has been expressed in other studies and reports. As mentioned earlier, the Bengal Chamber of Commerce [13] attributed the development of the sugar industry in Bengal to the catastrophic fall in the price of jute. Apart from this report, the studies of Aziz [3] and Rahman [36] can be cited as recognition in the scholarly literature of the role jute plays as a competing crop vis-à-vis sugarcane. Sugarcane may receive competition from other minor crops such as mustard, different kinds of pulses, etc., but such competition is considered insignificant. However, if an attempt were made to examine how these latter crops in fact do compete with sugarcane for resources, a lack of sufficient data on prices and yields of these minor crops would hamper such an attempt.

There is no consensus among researchers regarding the mathematical form of a supply response model due to the absence of any theoretical direction. For example, Anderson [1], Behrman [12], Jha [27], Wagle [42], and others have used a linear functional form for their models. On the other hand, some authors such as Madhavan [33] and Rathod [38] have used a log-linear model. In this study, the linear form is used because it is simple. Moreover, this form is more general than the log-linear form in the sense that the former allows supply elasticities to be different at different points of the supply curve.

The model is intended to explain variations in the planned or desired area of sugarcane in the mill zones of Bangladesh. But an area which is planned to grow a crop is an unobservable variable. So a proxy for this variable must be used. Two alternative hypotheses are made to measure the planned area of sugarcane. First, it is assumed that

$$SAREA_t^* = SAREA_t, \qquad (2)$$

where $SAREA_t$ is the actual planted area of sugarcane. This assumption implies that farmers instantaneously adjust their sugarcane area to the desired level in response to changes in expected price and other variables. Second, it is assumed, following Nerlove [34], that

$$SAREA_t = SAREA_{t-1} + \gamma(SAREA_t^* - SAREA_{t-1}),$$
$$0<\gamma\leq 1, \qquad (3)$$

where $SAREA_t^*$ and $SAREA_t$ are as defined above and γ is the coefficient of adjustment. This equation states that the actual planted area of sugarcane in period t is equal to the previous actual planted area plus a proportion of the difference between desired planted area in period t and actual planted area in period $t-1$. This hypothesis implies that farmers cannot fully adjust their actual planted area to the desired area in response to changes in the explanatory variables due to constraints such as fixity of assets, physical land conditions, habitual production patterns of the farmers, etc. In the special case when $\gamma = 1$, this hypothesis implies that the area adjustment is instantaneous.

One of the important explanatory variables which may influence the desired planted area of sugarcane is the expected price of the crop relative to that of the competing crop, jute. Since this variable is also unobservable, three alternative hypotheses are made as to how sugarcane growers form their expectations of the future price of sugarcane relative to that of jute. These hypotheses have been widely used in the studies of supply response of agricultural crops. The first hypothesis is called the naive or static expectations hypothesis. According to this hypothesis, expected price is equal to the latest known price. For the present case, this hypothesis implies that

$$RPR_t^* = RPR_{t-1}, \qquad (4)$$

where RPR_t^* is the expected relative price of sugarcane to jute in period t, and RPR_{t-1} is the actual relative price of sugarcane which prevailed in period $t-1$.[2]

[2] It is not an uncommon practice to apply the price expectations hypotheses, which were originally expressed in terms of the price of a single crop, directly to relative prices and even to relative revenues. For example, see [1], [25], etc.

This type of expectations hypothesis was originally used in the cobweb models and later found wide application in supply response studies (e.g., [27] [32] [40]). As Schultz noted, the drawback to such a model is that it implies that farmers do not learn from experience. But he also added, "Such a behavior is not to be ruled out as extremely improbable" [39, p. 78].

The second alternative hypothesis, originally introduced by Goodwin [21], is called the extrapolative expectations hypothesis. It assumes that expected price is the latest known price plus a certain fraction of the latest change in price. Following this hypothesis, it is assumed that

$$RPR_t^* = RPR_{t-1} + \sigma(RPR_{t-1} - RPR_{t-2}), \qquad -1 < \sigma < 1, \tag{5}$$

where RPR_t^* and RPR_{t-i} are as defined above and σ is the coefficient of aggregate expectations. The extrapolative expectations hypothesis encompasses a great variety of producer behavior depending on the sign of σ. If $\sigma = 0$, this hypothesis reduces to the static expectations hypothesis. Expectations continue to move in the same direction if $\sigma > 0$, but in the opposite direction if $\sigma < 0$. This hypothesis has also been widely used in supply response studies (e.g., [19] [20]).

The third alternative hypothesis used to model price expectations is the adaptive expectations hypothesis proposed by Nerlove [34]. It assumes that each year producers update their expectations for future "normal" price by an amount proportional to the error associated with the previous level of expectations. In terms of relative prices of sugarcane to those of jute, this hypothesis implies that

$$RPR_t^* - RPR_{t-1}^* = \delta(RPR_{t-1} - RPR_{t-1}^*), \qquad 0 < \delta \leq 1, \tag{6}$$

where all variables are defined as above. The parameter δ is the coefficient of expectations. If δ is equal to zero, actual relative prices of sugarcane to jute will have no effect whatsoever on the expected "normal" relative price of sugarcane; on the other hand, if δ is equal to one, expected normal relative price of sugarcane will be equal to last year's actual relative price [34]. The case of δ equal to one corresponds to the naive model.

Relative expected yield of sugarcane to jute is considered to be another important variable which influences the desired area under sugarcane in the mill zones of Bangladesh. This is because relative expected profitability of sugarcane as compared to jute depends not only on the relative expected prices and costs of production but also on the relative expected yields.

The same problem, as with expected relative price of sugarcane, arises as to how expected relative yields of sugarcane to jute will be incorporated into the model. In this study, two ad-hoc price expectations-types of hypotheses are used to measure the expected relative yield of sugarcane to jute. The first one is called the naive expectations of yield hypothesis which states that

$$RYLD_t^* = RYLD_{t-1}, \tag{7}$$

where $RYLD_t^*$ is the expected relative yield of sugarcane to jute in period t; $RYLD_{t-1}$ is the actual relative yield of the crop in period $t-1$. The second is called the extrapolative expectations hypothesis of yield. This hypothesis states that

$$RYLD_t^* = RYLD_{t-1} + \mu(RYLD_{t-1} - RYLD_{t-2}),$$
$$-1 < \mu < 1, \qquad (8)$$

where $RYLD_t^*$ and $RYLD_{t-i}$ are as defined above and μ is the coefficient of aggregate yield expectations.

The fact that price and yield risks influence farmers' decisions about allocating land among competing crops is generally admitted by researchers. Studies of supply response relationships by Behrman [12], Just [29] [30], Traill [41], etc. indicate that risk is an important factor in the decision-making process of farmers and that the inclusion of this variable into the model improves estimated supply response relationships. However, there is no consensus among the researchers as to how risk variables should be measured. As Dillon says, "Like beauty, risk lies in the eyes of the beholder!" [14, p. 28].

In this study, relative price or yield risk is measured by the ratio of the standard deviation of three preceding prices or yields of sugarcane to the standard deviation of three preceding prices or yields of jute. Mathematically, the procedure used here for measuring relative price risk can be expressed as

$$RPRR_t = [\sum_{i=1}^{3} (SPR_{t-i} - \overline{SPR}_t)^2/3]^{0.5} / [\sum_{i=1}^{3} (JPR_{t-i} - \overline{JPR}_t)^2/3]^{0.5}, \qquad (9)$$

where

$RPRR_t$ = relative price risk of sugarcane to jute in period t,

SPR_{t-i} = sugarcane price in period $t-i$,

$\overline{SPR}_t = \sum_{i=1}^{3} SPR_{t-i}/3$,

JPR_{t-i} = jute price in period $t-i$, and

$\overline{JPR}_t = \sum_{i=1}^{3} JPR_{t-i}/3$.

The measurement of the relative yield risk of sugarcane to jute can be defined in a similar way.

A dummy variable is included in the sugarcane area response model to measure the effects that opening a new sugar mill have on planted area. This variable takes a value of one in the year in which one or more new mills are established and zero otherwise. This dummy variable does not, however, sound theoretically plausible. The implication of this variable is that sugarcane growers will increase the area of cultivation in response to the establishment of a new sugar mill, but will withdraw the same area in the next year. Theoretically plausible dummy variables were tried in a preliminary analysis of the data, but they were found statistically insignificant. Moreover, they reduced the explanatory power of the models used. So, it was decided to use only one dummy variable, adopting the value one in the year in which one or more new sugar mills were established and zero otherwise. This dummy variable became highly significant and greatly outweighted the performance of the set of dummy variables which are theoretically more sound. Although it is very difficult to justify the present dummy variable theoretically, it is not so difficult empirically. In fact, this dummy variable is measuring the effect of the establishment of a new sugar mill on the marginal farmers who in fact were encouraged to begin growing sugarcane by virtue of such an opening. It appears that, in the following year, they decided not to grow sugarcane because they experienced some difficulties in selling sugarcane to the mills. Rahman [36] and Aziz [3] have noted some serious problems associated with the sale of sugarcane to the mills. Some of these difficulties directly related to the present situation are: (a) maldistribution of sugarcane selling permits to sugarcane growers, (b) usage of defective weighing machines at sugarcane purchasing centers, and (c) delay and unfair practices in payment of dues. All these problems and possibly others might have been responsible for the aforementioned marginal farmer behavior in response to the establishment of a new sugar mill. This behavior of the marginal sugarcane farmers is possibly being indicated by the dummy variable used in relation to the opening of new sugar mills.

The second dummy variable, DB_t, is included in the model to capture the effect of the government ban on the production of *gur* in the mill zones. The East Pakistan Government Gur, Sugar and Sugar Product Control Order of 1956 prohibiting *gur* production in the mill zones became effective in 1958/59 and was in force during the rest of the period in question. It is assumed that sugarcane farmers lagged two years in completely responding to this measure in terms of their area allocation decisions. The dummy variable therefore takes the value of one (representing no ban on *gur*) in 1959/60 and before, and zero thereafter.

The alternative hypotheses used to measure desired planted area, expected relative price of sugarcane to jute, and expected relative yield of sugarcane to jute give rise to a number of alternative models. These models are described below.

The incorporation of hypotheses (2), (4), and (7) into (1) gives rise to the traditional area response model:

$$SAREA_t = \alpha_0 + \alpha_1 RPR_{t-1} + \alpha_2 RYLD_{t-1} + \alpha_3 RPRR_t + \alpha_4 RYLDR_t + \alpha_5 DM_t + \alpha_6 DB_t + u_t. \quad (10)$$

This cobweb-type model is likely to be unsatisfactory in explaining sugarcane farmers' area response due to two reasons. First, it does not consider the fact that farmers' expectations of "normal" price may be influenced by a number of past prices rather than the most recent past price only. Second, it fails to consider that farmers may not be able to adjust fully their actual area under cultivation to the desired area due to the presence of some cost(s) for instantaneous adjustments. This model considers only the biological lag in production. It is used, however, as a benchmark in evaluating other alternative models.

Substitution of equations (2), (5), and (7) into (1) gives rise to the following model:

$$SAREA_t = \alpha_0 + \alpha_1(1+\sigma) RPR_{t-1} - \alpha_1\sigma RPR_{t-2} + \alpha_2 RYLD_{t-1} + \alpha_3 RPRR_t + \alpha_4 RYLDR_t + \alpha_5 DM_t + \alpha_6 DB_t + u_t. \quad (11)$$

This model is called the extrapolative expectations model.

Substituting equations (2), (6), and (7) into (1) and rearranging gives the following model:

$$SAREA_t = \alpha_0\delta + (1-\delta)\,SAREA_{t-1} + \alpha_1\delta\,RPR_{t-1} + \alpha_2\,RYLD_{t-1} - \alpha_2(1-\delta)\,RYLD_{t-2} + \alpha_3\,RPRR_t - \alpha_3(1-\delta)\,RPRR_{t-1} + \alpha_4\,RYLDR_t - \alpha_4(1-\delta)\,RYLDR_{t-1} + \alpha_5\,DM_t - \alpha_5(1-\delta)\,DM_{t-1} + \alpha_6\,DB_t - \alpha_6(1-\delta)\,DB_{t-1} + u_t - (1-\delta)\,u_{t-1}. \quad (12)$$

I will call it the adaptive expectations model. This model includes the assumption that lags in adjustment arise due to farmers' lags in adjusting their expectations for the future price level in the light of current price changes. However, it ignores the existence of costs for rapid adjustments.

Substituting equations (3), (4), and (7) into (1) and rearranging it gives the following model:

$$SAREA_t = \alpha_0\gamma + (1-\gamma)\,SAREA_{t-1} + \alpha_1\gamma\,RPR_{t-1} + \alpha_2\gamma\,RYLD_{t-1} + \alpha_3\gamma\,RPRR_t + \alpha_4\gamma\,RYLDR_t + \alpha_5\gamma\,DM_t + \alpha_6\gamma\,DB_t + \gamma u_t. \quad (13)$$

I will call it the partial adjustment model. This model assumes that lags in area adjustment arise due to the presence of adjustment costs, habitual production patterns, etc.

Substituting (3), (5), and (7) into (1) and rearranging gives the following model:

$$SAREA_t = \alpha_0\gamma + (1-\gamma)\,SAREA_{t-1} + \alpha_1\gamma(1+\sigma)\,RPR_{t-1} - \alpha_1\gamma\sigma\,RPR_{t-2} + \alpha_2\gamma\,RYLD_{t-1} + \alpha_3\gamma\,RPRR_t + \alpha_4\gamma\,RYLDR_t + \alpha_5\gamma\,DM_t + \alpha_6\gamma\,DB_t + \gamma\,u_t. \quad (14)$$

I will call it the partial adjustment–extrapolative expectations model.

The partial adjustment–adaptive expectations model is obtained by substituting equations (3), (6), and (7) into (1) and rearranging as follows:

$$SAREA_t = \alpha_0\gamma\delta + [(1-\delta) + (1-\gamma)]\,SAREA_{t-1} - (1-\delta)(1-\gamma)\,SAREA_{t-2} + \alpha_1\gamma\delta\,RPR_{t-1} + \alpha_2\gamma\,RYLD_{t-1} - \alpha_2\gamma(1-\delta)\,RYLD_{t-2} + \alpha_3\gamma\,RPRR_t - \alpha_3\gamma(1-\delta)\,RPRR_{t-1} + \alpha_4\gamma\,RYLDR_t - \alpha_4\gamma(1-\delta)\,RYLDR_{t-1} + \alpha_5\gamma\,DM_t - \alpha_5\gamma(1-\delta)\,DM_{t-1} + \alpha_6\gamma\,DB_t - \alpha_6\gamma(1-\delta)\,DB_{t-1} + \gamma\,u_t - \gamma(1-\delta)u_{t-1}. \quad (15)$$

This model takes into account both adjustment costs and lags in revising expected prices that are responsible for lags in adjustment of actual area to desired area.

Equations (10)–(15) are estimating equations. Another set of estimating equations could be obtained by replacing the naive yield expectations hypothesis with the extrapolative yield expectations hypothesis in all six estimating equations derived so far. In order to make the analysis less cumbersome, instead of estimating another set of six equations, the extrapolative yield expectations hypothesis is used to replace its naive counterpart only in the best of the six models described above. The results obtained from the new model are then compared with those obtained from the previous model and the better one is chosen.

III. THE DATA

Data covering the period 1947/48 to 1981/82 were collected on the following variables from various publications and sources.

(i) Sugarcane area—Data on the area under sugarcane cultivation in the mill zones were collected from the Bangladesh Sugar and Food Industries Corporation [11]. These data should be reliable because farmers in the mill zones are required to register their sugarcane areas with the sugar mills in order to receive selling permits. Cane development assistants[3] visit sugarcane areas in the mill zones and register the area under cultivation as well as assess the potential output.

(ii) Sugarcane purchasing price—There are two sets of prices at which sugar mills purchase sugarcane: (a) price at the mill-gates and (b) price at out stations. The price at out stations is slightly lower than at the mill-gates because a certain percentage is deducted from the mill-gate price to cover transportation costs to the mills, road cess, weight loss, etc. Since a larger percentage of growers supply their sugarcane through out stations, sugarcane price there has been used in this study. These prices for the period 1947/48 to 1952/53 were obtained from the Directorate of Agricultural Marketing [18] and for the period 1953/54 to 1981/82 from the Bangladesh Sugar and Food Industries Corporation [11]. Since the sugarcane purchasing price is determined every year by the government, there is no problem in combining the two price series.

(iii) Jute price—National jute prices at the growers level over the period 1947/48 to 1981/82 were obtained from various sources. Separate data on these prices are not available for the mill zones. The sources from which these prices were obtained are the Bangladesh Bureau of Statistics [4] [6] [8], the East Pakistan Bureau of Statistics [17], the World Bank [43], and the Ministry of Agriculture [9]. Prices obtained from various sources may not be comparable, since they may have used a different definition or method in constructing their price series. So the regression results based on these data should be considered in the light of such problems.

(iv) Sugarcane yield—The data on sugarcane yield in the mill zones were obtained from the Bangladesh Sugar and Food Industries Corporation [11]. These data were calculated by simply dividing the total production of sugarcane by sugarcane area in the mill zones.

(v) Jute yield—Jute yield figures for the mill zones are not available. So national figures have been used in this study. These figures were obtained in two steps. First, total area under jute cultivation and production figures for Bangladesh were obtained from the Bangladesh Bureau of Statistics [5] [7] [8] for the period 1947/48 to 1981/82. The jute yield figures were then calculated by simply dividing the total production of jute by the jute area. Although this data series was

[3] Cane development assistants are employed by sugar mills. Their main tasks are to advise sugarcane growers on the best methods available for cultivating the crop and at the same time record the area under cultivation.

obtained from only one source, it should be borne in mind that this data is only a proxy for its counterpart in the mill zones.

IV. ESTIMATION AND EVALUATION OF THE MODELS

The traditional area response model, the extrapolative expectations model, the partial adjustment model, and the partial adjustment–extrapolative expectations model are estimated by the ordinary least squares (OLS) technique. The OLS estimators of the parameters in the traditional area response model and the extrapolative expectations model are the best linear unbiased estimators, provided that disturbances in these models are independently and identically distributed with zero mean and constant variance. Also, the OLS estimators of the parameters in the partial adjustment model and the partial adjustment–extrapolative expectations model are consistent and asymptotically efficient under regular assumptions made about disturbance terms. The parameters in the adaptive expectations model and the partial adjustment–adaptive expectations model are estimated by the nonlinear least squares technique with the assumption that u_t is distributed identically and independently with zero mean and constant variance. Under this assumption the nonlinear least squares estimators of the parameters of these two models are consistent and asymptotically efficient.

Data covering the period 1947/48 to 1981/82 were collected for this study. However, actual estimation cannot be started from 1947/48 due to two reasons. First, construction of the series of the risk variables uses up three observations from 1947/48 to 1949/50. Second, a comparison of the statistical performance of alternative models requires that the same number of observations be used in the estimation of the models. To meet this requirement another two observations, 1950/51 and 1951/52, cannot be used since some models include variables which lagged for up to two years. So, actual estimation of the models has been done using data from 1952/53 to 1981/82.

As can be seen from the second column of Appendix Table I, the static or traditional area response model explains 84.1 per cent of the total variation of sugarcane area over the period under study. All estimated parameters have economically meaningful signs. All of them are significantly different from zero at the 10 per cent level or better. The F-statistic indicates that the relationship between sugarcane area and the explanatory variables is significant at the 1 per cent level. However, the Durbin-Watson (DW) [16] d-statistic failed to suggest whether this model suffers from the autocorrelation problem. In other words, the test for non-autocorrelation against first-order autocorrelation turned out to be inconclusive.

It was expected a priori that the traditional area response model would not adequately explain the data, because this model does not take into consideration the dynamic aspects of supply. In other words, it does not consider the fact that sugarcane growers may lag in adjusting their actual area to the desired level. The inconclusive test for non-autocorrelation can be considered as an indication of the inadequacy of this model in explaining variations in sugarcane area. Alternatively, it could imply that this model is misspecified and necessitating a correctly specified model.

The extrapolative expectations model, which was obtained by replacing the naive price-expectations hypothesis in the traditional area response model by the extrapolative price-expectations hypothesis, has parameter estimates with expected signs (see the third column of Appendix Table I). One-sided t-tests indicate that all estimated coefficients, except that of relative price lagged two years (RPR_{t-2}), are significantly different from zero at the 5 per cent probability level or better. The non-significance of the coefficient of RPR_{t-2} suggests that the extrapolative price-expectations hypothesis is not an appropriate hypothesis concerning the formation of expected price. The inconclusive result of the test for non-autocorrelation, as indicated by the d-statistic, also indicates that the extrapolative expectations model is misspecified.

The nonlinear least squares estimates of the adaptive expectations model with other summary statistics are reported in the second column of Appendix Table II. As can be seen from that column, all parameter estimates are significantly different from zero at the 10 per cent significance level or better and have economically meaningful signs. Moreover, the coefficient of expectations has a magnitude which lies within the expected range of zero to unity. Whether this model suffers from the autocorrelation problem or not cannot be tested by using the DW d-statistic, since this model includes a lagged dependent variable in the set of regressors. In the presence of a lagged dependent variable in a regression equation, the DW d-statistic is likely to have reduced power and is biased toward the value 2 [15] [28, p. 326] [35]. For such an equation, Durbin has suggested an alternative test statistic known as the h-statistic [15]. The h-statistic is defined as

$$h = (1 - 0.5d)\{n/[1 - n\hat{V}(1)]\}^{0.5},$$

where $\hat{V}(1)$ is the least squares estimate of the variance of the coefficient of the lagged dependent variable, d is the usual DW d-statistic, and n is the number of observations used to estimate the parameters. Under the null hypothesis of no autocorrelation, h is asymptotically normal with zero mean and unit variance. The test statistic can also be used to test the hypothesis of no serial correlation against first-order autocorrelation, even if the set of regressors in an equation contains higher order lags of the dependent variable.

Unfortunately, since the value of $n\hat{V}(1)$ turned out to be greater than unity, the h-statistic is not defined for this model. However, an analysis of the correlogram of the residuals suggested that neither the first-order nor higher-order lag correlations of the residuals were significantly different from zero at the 5 per cent probability level. From this result, it can be concluded that the adaptive expectations model does not suffer from the serial correlation problem and, as a result, its nonlinear least squares estimates are consistent and asymptotically efficient.

The appropriateness of the adaptive price-expectations hypothesis can be judged by testing the null hypothesis that the expectations coefficient is unity ($\delta = 1$) against the alternative $\delta < 1$. An asymptotic t-test suggested that the null hypothesis could not be rejected at the 5 per cent level of significance. An asymptotic F-test [37, pp. 141–45] involving residual sums of squares of the traditional area response model (restricted model) and of this model (unrestricted model) was also done to test the same null hypothesis. This test resulted in the non-rejection of the null hypothesis at the 5 per cent probability level. So, if the value of the expectations coefficient is restricted to unity, the adaptive expectations hypothesis collapses to the naive expectations hypothesis and the adaptive expectations model collapses to the traditional area response model. In other words, on the basis of the sample information we can conclude that the adaptive expectations hypothesis is not the appropriate one in modeling farmers' expectations about future prices. Rather, the relatively simpler naive expectations hypothesis is the appropriate one.

The results obtained from the partial adjustment model, which was derived by replacing the instantaneous area adjustment hypothesis in the traditional area response model by the partial adjustment hypothesis, are reported in the fourth column of Appendix Table I. This model performs better than the traditional model in terms of explanatory power indicated by $\bar{R}^2$. The value of $\bar{R}^2$ is 0.80 in the traditional model; but it increases to 0.84 when the partial adjustment model is fitted to the data. All parameter estimates of the latter model have economically meaningful signs and are asymptotically significant at the 10 per cent or better probability level. The h-statistic reported with the parameter estimates indicates that this model does not suffer from the serial correlation problem. This fact can be considered as further evidence of the superiority of the partial adjustment model to the traditional area response model.

The appropriateness of the partial adjustment hypothesis can be formally tested by testing the significance of the coefficient of $SAREA_{t-1}$ in the partial adjustment model. It was found that the coefficient of this variable is significantly different from zero (or the coefficient of area adjustment is significantly different from unity) at the 2.5 per cent level of significance. So, it can be concluded that the partial adjustment model is a better model of sugarcane area response than the traditional area response model.

The nonlinear least squares estimates of the partial adjustment–adaptive expectations model are reported with other summary statistics in the third column of Appendix Table II. All estimated parameters of this model have economically meaningful signs and all of them are asymptotically significant at the 10 per cent probability level or better. Both the adjustment coefficient (γ) and the price expectations coefficient (δ) have estimated values which lie within the a priori expected range of zero to unity. Whether this model suffers from serial correlation could not be tested by using the h-statistic, since $n\hat{V}(1)$ is greater than unity. However, an analysis of the correlogram of the residuals suggests that the model does not suffer from serial correlation.

The appropriateness of the partial area adjustment hypothesis can be judged once again by testing the null hypothesis $\gamma = 1$ against the alternative $\gamma < 1$ on the basis of the results of this model. An asymptotic t-test suggests that the null hypothesis can be rejected in favor of the alternative at the 2.5 per cent probability level. That is, on the basis of the sample information we can conclude that the partial adjustment hypothesis is an appropriate hypothesis concerning the nature of area adjustment by the sugarcane growers in the mill zones. They cannot fully adjust their actual sugarcane area to the desired level in a single year in response to a change in the expected relative price of sugarcane to jute, ceteris paribus.

Similarly, the validity of the adaptive price-expectations hypothesis can be judged again by testing the null hypothesis $\delta = 1$ against the alternative $\delta < 1$ on the basis of the results obtained from this model. An asymptotic t-test suggests that the null hypothesis $\delta = 1$ cannot be rejected at the 5 per cent probability level. That is, sample information once again suggests that the appropriate hypothesis in modeling sugarcane farmers' expectations of future prices is the naive expectations hypothesis. This result also suggests that between the partial adjustment model and the partial adjustment–adaptive expectations model, the former is the appropriate one. Because if the value of δ is restricted to unity, the latter collapses to the former model.

The performance of the partial adjustment–extrapolative expectations model is not better than that of the partial adjustment model in terms of explanatory power as indicated by the $\bar{R}^2$ (see the fifth column of Appendix Table I). The former model includes an additional explanatory variable RPR_{t-2} compared to the latter, but its coefficient is not significantly different from zero at the 10 per cent level of significance indicating that the extrapolative price-expectations hypothesis is not appropriate to measure expected prices. However, coefficients of the other variables are significantly different from zero at the 5 per cent level of significance or better, and this model does not suffer from autocorrelation.

So it is established that, of the six models considered so far, the partial adjustment model is the best one. At this stage, another model is formulated and estimated by replacing the naive yield expectations hypothesis in the partial adjustment model by the extrapolative yield-expectations hypothesis. The new model is

$$\begin{aligned} SAREA_t = {} & \alpha_0\gamma + (1-\gamma)\,SAREA_{t-1} + \alpha_1\gamma\,RPR_{t-1} \\ & + \alpha_2\gamma(1+\mu)\,RYLD_{t-1} - \alpha_2\gamma\mu\,RYLD_{t-2} \\ & + \alpha_3\gamma\,RPRR_t + \alpha_4\gamma\,RYLDR_t + \alpha_5\gamma\,DM_t \\ & + \alpha_6\gamma\,DB_t + \gamma\,u_t. \end{aligned} \qquad (16)$$

The difference between this model and the partial adjustment model is that it contains an additional variable ($RYLD_{t-2}$) relative to the latter. The results from this model are given in the sixth column of Appendix Table I. This model does not suffer from the problem of serial correlation. All parameter estimates have economically plausible signs. Apart from the coefficient of $RYLD_{t-2}$, all parameters are significantly different from zero at the 10 per cent level of significance or better. However, this model has less explanatory power than the partial adjustment model, indicating that $RYLD_{t-2}$ is an irrelevant variable in the model. Moreover, the nonsignificance of the parameter of $RYLD_{t-2}$ indicates that the extrapolative yield-expectations hypothesis is not suitable in modeling expected yields.

Although the partial adjustment model has come out as the best model of all considered so far, it still suffers from a limitation. It is implied by the structure

TABLE I

OLS ESTIMATES OF THE PARTIAL ADJUSTMENT MODEL OF SUGARCANE AREA RESPONSE IN THE MILL ZONES OF BANGLADESH AFTER INCLUDING ABSOLUTE PRICES OF JUTE AND SUGARCANE, 1952/53 TO 1981/82

Explanatory Variable	Estimates with Standard Errors in Parentheses
Constant	28.328 (15.096)
$SAREA_{t-1}$ (Sugarcane area lagged one year)	0.173* (0.115)
SPR_{t-1} (Sugarcane price lagged one year)	0.161**** (0.040)
JPR_{t-1} (Jute price lagged one year)	−0.012**** (0.004)
$RYLD_{t-1}$ (Relative sugarcane yield lagged one year)	1.239*** (0.590)
$RPRR_t$ (Relative sugarcane price risk)	−104.280**** (27.789)
$RYLDR_t$ (Relative sugarcane yield risk)	−0.059 (0.047)
DM_t (Dummy variable for new sugar mills)	11.984**** (3.083)
DB_t (Dummy variable for the ban on *gur*)	−28.935**** (5.297)
R^2	0.924
$\bar{R}^2$	0.896
F (8, 21)	32.118
h-statistic	−0.698
n	30

**** Significant at 1.0 per cent level.
*** Significant at 2.5 per cent level.
** Significant at 5.0 per cent level.
* Significant at 10.0 per cent level.

of the model that the own-price elasticity of area is equal to the cross-price elasticity of area in absolute magnitude. The same restriction holds with respect to yield and risk ratios. These restrictions are imposed due to the inclusion of prices, yields, and risks in ratio form rather than in absolute form. To test whether these restrictions are valid or not, the partial adjustment model is re-estimated by including prices of sugarcane and jute, separately keeping other variables in ratio form. The results thus obtained are reported in Table I. All estimated coefficients have economically meaningful signs. Moreover, all of them are significantly different from zero at the 10 per cent significance level or better except the coefficient of $RYLDR_t$. However, the increase of the value of $\bar{R}^2$ from 0.836 in the previous model to 0.896 in the present model strongly suggests that own-price elasticity and cross-price elasticity are not the same in absolute magnitude. Similar exercises were performed with respect to other ratio variables, but they led to deterioration in the explanatory power of the model.[4]

V. ECONOMIC INTERPRETATIONS OF THE RESULTS OF THE BEST MODEL

It was found in the previous section that the partial adjustment model with prices modeled separately is the best of all models considered to explain variations in sugarcane area. On the basis of the information contained in the sample, the hypothesis that farmers in the mill zones cannot fully adjust their actual sugarcane area to the desired level in a single year in response to a change in their economic environment could not be rejected. Further analysis of the results of the best model shows that sugarcane growers can materialize about 83 per cent of the desired change in the area under cultivation in a single year by responding to changes in the expected sugarcane price. It takes them about two years to complete the desired change in area size in response to changes in the economic conditions they face (see Table II).

Of the hypotheses used to model price and yield expectations of sugarcane farmers, the naive expectations hypothesis was found to be the appropriate one. That is, in forming expectations about future prices or crops yields sugarcane farmers use only information contained in last year's price or yield. This result is perhaps not unexpected for farmers in a developing country like Bangladesh, where most are illiterate and have a very short memory of past prices and yields.

The results obtained with the best model suggest that sugarcane growers in the mill zones are responsive to market forces reflected in price. Jute competes with sugarcane for land and non-land inputs. In deciding on sugarcane area allocation, farmers respond positively to changes in sugarcane price and negatively to changes in jute price. They also appear to consider the sugarcane yield relative to jute yield per hectare, the sugarcane price risk relative to jute price risk, and the relative sugarcane yield risk to jute yield risk in making decisions with respect to allocation of area between these two crops.[5] They respond positively to changes in the ratio of sugarcane yield to jute yield and respond negatively to changes in

[4] In a preliminary analysis, prices, yields, and risk variables were included separately in the models instead of in ratio form. The estimated models were found to be plagued with a severe multicollinearity problem. To overcome this problem, it was decided to estimate the models first in ratio form and then relax the restrictions on elasticities one by one.

[5] Note that in the chosen model the coefficient of the relative yield risk variable is not statistically different from zero (see Table I). The normal interpretation of this result is that the relative yield risk variable has no effect on sugarcane area. This author would argue that in the present case this interpretation should be disregarded, because this coefficient is theoretically expected to be significant, and this is consistently the case in all regression models except the chosen one. Moreover, in the chosen model the t-value of the coefficient narrowly fails to exceed the critical value of t at the 10 per cent level of significance. These facts suggest that the relative yield risk variable influences sugarcane area, but this is not statistically obvious from the results of the chosen model.

TABLE II

ESTIMATES OF THE IMPORTANT PARAMETERS IN SUGARCANE AREA RESPONSE IN THE MILL ZONES OF BANGLADESH, 1952/53 TO 1981/82

Parameter	Magnitude	
	Short Run	Long Run
Own-price elasticity	0.360	0.435
Cross-price elasticity	−0.274	−0.331
Own-yield elasticity	0.467	0.565
Cross-yield elasticity	−0.467	−0.565
Own-price-risk elasticity	−0.080	−0.097
Cross-price-risk elasticity	0.080	0.097
Own-yield-risk elasticity	−0.039	−0.047
Cross-yield-risk elasticity	0.039	0.047
Area-adjustment coefficient	0.827	
Number of years required for 95 per cent adjustment to materialize in response to a change in expected price, ceteris paribus	1.710	

Note: The elasticities reported in this table are calculated at mean values.

price and yield risk of sugarcane relative to price and yield risk of jute. The short- and long-run elasticities of sugarcane area with respect to these variables are shown in Table II. It is found from this table that both short- and long-run price elasticities of sugarcane area are less than one, implying inelastic area response to sugarcane price. The case is similar with respect to yield elasticities. However, the long-run elasticities are greater than the short-run elasticities. This is because sugarcane growers have more time in adjusting their area under the crop in the long run than in the short run. The elasticity estimates of this study compare well with the estimates of other studies of sugarcane such as Jha [27], Kaul [31], Lal and Singh [32], and Madhavan [33]. A detailed comparison can be found in Jaforullah [26].

It can be seen from Table II that sugarcane growers are responsive to movements in both price and yield risk although not to a great extent. They are found to be "risk adverse."

The coefficient of the dummy variable DM_t, which represents the opening of a new sugar mill, is highly significant and has a positive sign (see Table I). This result implies that the opening of a new sugar mill induced some marginal farmers to increase area under sugarcane cultivation. However, the incentive provided could not be sustained. Marginal growers were probably discouraged by the difficulties in obtaining permits and other problems associated with selling sugarcane to the mills. As a result, they switched to the production of alternative crops in the next year. This result suggests that the sugar mills can encourage marginal farmers to bring some land under sugarcane cultivation by simply improving the present system of permit distribution and sugarcane purchasing.

From Table I, it can be seen that the estimated coefficient of the dummy variable DB_t, which is included to measure the effect of the government's *gur* production ban on sugarcane area, is negative and statistically significant. This result indicates that the prohibition of *gur* production in the mill zones led to an increase in sugarcane area. Aziz [3] has shown on the basis of a farm survey that *gur* production is more profitable than the sale of sugarcane to the mills. Then the question arises: why did farmers increase the area under sugarcane cultivation, even if *gur* production was prohibited? It is not hard to find the answer to this question. The land used to grow sugarcane in the mill zones is especially suitable for this crop, and the opportunity cost of producing sugarcane is less than the revenue earned by producing it for a wide range of sugarcane prices. Because of this, farmers previously using sugarcane for *gur* production were forced to sell their sugarcane to the mills. As a result, the total area of sugarcane registered with the sugar mills showed an increase.

VI. CONCLUSIONS

The present study has been directed to identifying economic factors responsible for variations in sugarcane area over the period from 1947/48 to 1981/82 and the measurement of their effects. It was found that sugarcane area is responsive to changes in sugarcane price, jute price, and sugarcane yield relative to jute yield. Sugarcane area is also responsive to changes in sugarcane price risk relative to jute price risk and sugarcane yield risk relative to jute yield risk. It was also found that growers lag in adjusting the area allocated to sugarcane in response to any change in the above-mentioned factors.

It follows from this study that the sugar mills and the government of Bangladesh should adopt policy measures that take account not only of sugarcane price and yield, but also of the price and yield of jute, if they want their policy to be successful in assuring adequate supplies of sugarcane to the mills. They should also take into account the price and yield uncertainties of sugarcane relative to those of jute.

Though prices can be manipulated more easily than other policy instruments in influencing sugarcane producers' decisions, the results of this study suggest that adequate supplies to the mills cannot be ensured by pricing policy alone. The inelastic nature of the supply of sugarcane in the long run with respect to its price suggests that the usefulness of a pricing policy as an instrument to induce sizable shifts in sugarcane area in the long run is rather limited. Moreover, considering the fact that the sugar mills are already suffering from high costs of production [2, p. 6], there is little room for pushing sugarcane prices higher until some measures are taken to reduce costs of production.

However, the government can take policy measures directed toward increasing sugarcane yield per hectare, in order to achieve targets of increased production resulting in adequate supplies to the sugar mills. It is found in this study that the elasticity of sugarcane area with respect to yield is higher than its elasticity with respect to price. This result suggests that the government should undertake measures to increase sugarcane yield per hectare to complement appropriate pricing policy.

It can also be suggested that the government should make a thorough investigation into the allegations made in Rahman [36] relating to the purchasing of sugarcane by the mills and take corrective measures. Fair trading practices legislation might encourage potential marginal farmers to grow more sugarcane.

Finally, it should be noted that the conclusions drawn here are based on the data from 1947/48 to 1981/82. In the absence of any significant change in the sugarcane industry since then, these conclusions are no doubt still valid. However, further research could be undertaken at a later date to investigate whether there has been any significant structural change in sugarcane area response since 1981/82.

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APPENDIX TABLE I

OLS ESTIMATES OF VARIOUS MODELS OF SUGARCANE AREA RESPONSE IN THE MILL ZONES OF BANGLADESH, 1952/53 TO 1981/82

Variable	Traditional Area Response Model	Extrapolative Expectations Model	Partial Adjustment Model (PAM)	Partial Adjustment-Extrapolative Expectations Model	PAM with Extrapolative Expectations of Yield
Constant	13.241	9.826	1.577	−1.535	7.544
	(18.748)	(19.033)	(17.558)	(17.742)	(19.732)
$SAREA_{t-1}$	—	—	0.332***	0.328***	0.366****
			(0.133)	(0.133)	(0.143)
RPR_{t-1}	222.130****	228.620****	183.650***	190.200***	195.240***
	(84.222)	(84.401)	(77.578)	(77.570)	(80.254)
RPR_{t-2}	—	81.900	—	77.527	—
		(80.515)		(72.525)	
$RYLD_{t-1}$	1.866***	1.659**	1.526***	1.335**	1.548***
	(0.786)	(0.811)	(0.722)	(0.742)	(0.732)
$RYLD_{t-2}$	—	—	—	—	−0.424
					(0.610)
$RPRR_t$	−104.960****	−105.620****	−90.545****	−91.326****	−90.139****
	(37.962)	(37.939)	(34.752)	(34.648)	(35.172)
$RYLDR_t$	−0.110*	−0.119**	−0.098*	−0.106*	−0.102*
	(0.069)	(0.069)	(0.062)	(0.063)	(0.063)
DM_t	12.720****	14.355****	11.007****	12.573****	11.004****
	(4.194)	(4.489)	(3.848)	(4.106)	(3.894)
DB_t	−42.590****	−44.237****	−29.948****	−31.639****	−29.371****
	(5.426)	(5.659)	(7.048)	(7.201)	(7.180)
R^2	0.841	0.848	0.876	0.882	0.879
$\overline{R}^2$	0.799	0.800	0.836	0.838	0.833
$F(\nu_1, \nu_2)$	20.243(6,23)	17.525(7,22)	22.181(7,22)	19.677(8,21)	19.013(8,21)
d-statistic	1.249	1.228	—	—	—
h-statistic	—	—	1.220	1.270	0.903
n	30	30	30	30	30

Note: Standard errors of the estimates are given in parentheses.
**** Significant at 1.0 per cent level.
*** Significant at 2.5 per cent level.
** Significant at 5.0 per cent level.
* Significant at 10.0 per cent level.

APPENDIX TABLE II

NONLINEAR LEAST SQUARES ESTIMATES OF THE ADAPTIVE EXPECTATIONS MODEL AND THE PARTIAL ADJUSTMENT–ADAPTIVE EXPECTATIONS MODEL OF SUGARCANE AREA IN THE MILL ZONES OF BANGLADESH, 1952/53 TO 1981/82

Structural Parameter[a]	Estimates of the Adaptive Expectations Model[b]	Estimates of the Partial Adjustment–Adaptive Expectations Model[b]
α_0	8.046 (19.876)	−1.672 (25.490)
α_1	325.665** (164.851)	401.404** (212.646)
α_2	1.670** (0.845)	1.954** (1.073)
α_3	−104.705**** (37.723)	−135.245*** (54.281)
α_4	−0.114* (0.070)	−0.152* (0.091)
α_5	13.966**** (4.423)	17.293**** (5.893)
α_6	−43.918**** (6.223)	−46.862**** (8.647)
δ (coefficient of expectations)	0.682*** (0.297)	0.662*** (0.299)
γ (coefficient of adjustment)	—	0.699**** (0.120)
$F(\nu_1, \nu_2)$	17.449(7, 22)	19.893(8, 21)
R^2	0.847	0.883
$\bar{R}^2$	0.798	0.838
n	30	30

[a] These parameters relate to structural equations (1), (3), and (6).
[b] The figures in parentheses are standard errors.
**** Significant at 1.0 per cent level.
*** Significant at 2.5 per cent level.
** Significant at 5.0 per cent level.
* Significant at 10.0 per cent level.