THE DETERMINANTS OF ACREAGE UNDER JUTE IN BANGLADESH, INDIA AND THAILAND: 1950-1975*

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ABSTRACT

In this study, a general model of annual jute acreage is developed, based on the assumptions of lagged adjustment of actual to desired area, and "naive" price expectations. A number of different formulations see examined empirically in order to arrive at the particular general model. The results of fitting this model to data from the three major producing countries-Bangladesh India, and Thailand indicate that jute garage is indeed quite responsive to changing economic factors. The elastic nature of jute acreage to prices, both of jute and of rice or other alternative crops, is an important aspect of the world jute market. The analysis suggests that the principal determinant of area under jute in these countries is the jute farmer's expectations of the relative price of jute compared to the alternative crops, which is largely determined by is preceding year's prices.

I. INTRODUCTION

Jute is second only to cotton in its importance as a vegetable fibre and, together with kenaf and roselle, has long been of major importance to agriculture in many parts of the tropics and the subtropics as a cash crop and as raw material for agro-industries. One important feature of the world jute economy is its importance and concentration of production in three areas-Bangladesh, India, and Thailand. Although during 1952-1955 these three countries accounted for about 88 percent of the world supply of jute on *the* average, their share is reduced to only about 46 percent during 1974-1975. It should be noted in this connection that Indian production aims mainly at satisfying domestic demand for its jute manufacturing industry (until 1966-1967, India was a net importer of raw jute). Similarly, supply of jute in smaller producing countries is generally absor-

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bed by local consumption. Thus almost all the raw jute that is traded in the world market originates mainly in two developing countries—Bangladesh and Thailand. [A further feature of jute production is its absolute importance to the economy of these areas of low per-capita income. For example, export earnings from raw jute accounted for 52 percent of total export earnings of Bangladesh in 1971-1972 and almost 15 and 10 percent for India and Thailand respectively during the same period.]

The world production of jute has been increasing since World War II. The annual supply levels, however, have been characterized by substantial fluctuations. The unstable climatic conditions in the "jute-belt" of Bangladesh and India constitute one of the most important factors in these fluctuations. However, the principal determinant of acreage and hence production in this area seems to be the fact that jute happens to be the cash crop in the region where intense population pressure and subsistence rice farming are the dominant features of small-holding agriculture. This paper describes an econometric analysis of the acreage under jute in the three countries mentioned above. Annual data from 1949-50 to 1974-75 were used in the estimation (except for Thailand where the time period was 1960-1975). In addition, the paper provides further evidence for the debate over the supply responsiveness of peasant producers. The results are suggestive in respect to this general controversy. The study is part of a larger study of the world jute market and was undertaken to provide production equations for an annual world jute market model (Mujeri 1978, 1979). The study is organized as follows. First, a theoretical model explaining the area under jute is described, followed by a discussion on some of the statistical problems faced in fitting the model to the time-series data. Estimation results are then presented and compared for the three countries studied. Finally some general conclusions are given about the nature of the determinants of the area under jute production. Variable definition and data sources are given in the Appendix.

II. CONSTRUCTING A GENERAL MODEL

Jute is an annual and seasonal crop, which is a bast fibre produced mainly from two annual species *Corchorus Capsularies* (white jute) and *Corchorus Olitorius* (tossa, also known as upland jute). There are also a number of substitutes or jute, the chief of these being kenaf (also called mesta, Siam jute, Ambari hemp, stockroos, etc.) obtained from *Hibiscus Cannabinus*, roselle obtained from *Hibiscus Sabdariffa*, and urena fibre (also called *Congo jute* or paka) obtained from *Urena Lobata*. The environmental requirements for successful cultivation of jute are relatively specialized, while one or more of the jute-like fibres can be grown in almost any tropical country of the world.

Basically, the area under the cultivation of jute, like that under any other agricul-tural commodity, rests on the micro-relationships within agriculture. Estimation of acreage functions from aggregate data leads to one of the most complex econometric problems which influences not only the choice of explanatory variables but also the relia-bility of estimated parameters. Since acreage decisions are made at the micro-level, the estimation of aggregate acreage function itself involves the transition from micro to approximately equivalent macro-relationships which are of direct interest for policy purposes. Furthermore, the necessity of confining to a few relevant explanatory varia-ables in time series analysis is itself a form of the agregation problem.

In order to obtain accurate estimates of area under jute, it is necessary to determine the variables that may be considered important in explaining the actual acreage under jute. In the predominantly rice-growing areas of Bangladesh and India, rice is grown as the staple food crop, while jute is the principal cash crop of the farmers. The jute-rice price ratio has long been recognized as a key determinant of the area under jute vis-a-vis rice. The hypothesis has been advanced that the proportion (or amount) of land devoted to jute will rise as the ratio of expected jute prices to expected rice prices increases, and will fall as the ratio decreases.[4] However, the true nature of the relationship between area under jute and jute and rice prices is a matter for conjecture and assumption.

While the historical relationship between area under jute and jute-rice prices are no doubt important, any precise estimation of the jute acreage function should also con-sider the relative costs of production and yields in order to get some measure of net re-turns, and some measure of changes in technology, if any, which occurred during the period. Small growers do not, of course, make precise calculations of net returns when the yields from one unit of land under jute and rice are very different (especially with improved varieties of rice), the choice of the crop may not be based on a straight comparision of expected prices, but on a comparison, however unsophisticated, of net returns. The cost of producing jute varies considerably according to the areas in which it is grown and to the conditions of cultivation. One FAO study has examined the costs of production of both jute and rice under both traditional and imporoved methods of cultivation in Bangladesh during 1974-75 (FAO 1975, pp. 2-4). The study indicates that under the traditional method, which is still widely prevalent, the costs of production of jute and aus rice are quite comparable and hence expected prices of the crops can be considered as depicting fairly the net returns of both the crops.

Further, it seems impossible to employ all the variables in estimating jute acreage equations because of limited observation and, in some cases, some of the variables are

difficult to quantify because of the lack of continuous and reliable information for the countries concerned. Input prices and technology will be ignored mainly due to the lack of adequate information. This can be justified by the fact that the production of jute in these countries is still predominantly a product of subsistence cultivation.

III. FORMULATION OF JUTE ACREAGE FUNCTION

An agricultural supply response model, in terms of area under the crop of concern, typically has the form

$$ACR_t^* = a_0 + a_1 P_t^* + a_2 Z_t \qquad \qquad \qquad (1)$$

where

ACR_t^* = desired acreage at time t

P_t^* = expected price level[5] at time t

Z_t = a surrogate for non-price variables, and

a_0, a_1, and a_2 are the regression coefficients to be estimated. The traditional short run supply response model assumes that $ACR_t^* = ACR_t$ and $P_t^* = P_{t-1}$, that is, farmers fully adjust to their desired acreage each year according to the price level in the preceding year. However, the traditional model often fails to explain the farmers' supply response due to two reasons. First, farm product prices fluctuate considerably from year to year around a long term trend. Farmer's expectations of future prices are therefore likely to depend not just on immediate past prices but on a number of years prices, from which the farmers would arrive at an expected price level[6]. Secondly, farming is characterized by near-perfect competition on the output side and "asset fixity" on the input side. Thus while farmers are price-takers, they cannot always readily adjust to price changes in the short run.[7]

It may be argued, however, that the problem of "asset fixity" is not substantial in the case of jute production. Almost all the jute growers are primarily rice growers and their land and other inputs are readily interchangeable between their cultivation. It may thus be a reasonable approximation to assume $ACT_t^* = ACR_t$. The validity of this assumption is considered later on in this section. Using the notion of adaptive expectations (Nerlove 1958), we can write :

$$P_t^* - P_{t-1}^* = b[P_{t-1} - P_{t-1}^*] \qquad \qquad \qquad (2)$$

where b is called the "coefficient of expectations". Note that if $b=0$, then actual values of past prices have no effect on expected prices; while if $b=1$, then the actual values of price in year $t-1$ is projected as the forecast price in year t. That is, expectations are "naive". Assuming $ACR_t^* = ACR_t$, equation [2] can be substituted in equation [1] to

$$ACR_t = a_0 b + a_1 b\ P_{t-1} + (1-b)\ ACR_{t-1} + a_2\ Z_t + (b-1)a_2\ Z_{t-1} \qquad .. \qquad (3)$$

obtain which provides simultaneous estimates for both the short-and the long-run price elasticities of acreage.

However, it might be necessary to build into the jute acreage equation the essential dynamic aspect that the level of a country's area under jute cannot be changed rapidly in the short-run in response to changing economic conditions. In building this dynamic aspect, the adjustment lag, following Nerlove (Nerlove 1958), may be specified as :

$$ACR_t - ACR_{t-1} = \lambda[ACR_t^* - ACR_{t-1}],\ 0 \leq \lambda \leq 1,\ \lambda\ \text{constant} \qquad .. \qquad (4)$$

The size of the fraction λ, the "coefficient of adjustment", is a measure of the speed with which actual acreage adjusts in response to factors determining desired acreage. Such factors will vary for different countries and the adjustment speed is determined by the institutional, technological, and behavioral rigidities. If [4] is substituted into equation [1] and it is assumed that the previous year's price level is the expected price for this year, then a model similar to the adaptive expectations model [3] is obtained, with Z_{t-1} excluded. This has come to be known as the "partial adjustment model". However, despite the mathematical similarities of the final acreage equations, whereas the adaptive expectations model reflects the values of the variables such as prices which in turn determine the acreage ; the partial adjustment model, on the other hand, reflects the technological and institutional constraints which permit only a fraction of the intended acreage to be realized during a given short period. In reality, both types of lags are important and neither can be supposed, a priori, to be non-existent. When both are incorporated in model [1] and Z is omitted for simplicity, the following "expectations and adjustment model" results :

$$ACR_t = c_0 + c_1\ P_{t-1} + c_2\ ACR_{t-1} + c_3\ ACR_{t-2} \qquad .. \qquad (5)$$

form which it can be shown that

$$b,\ \lambda = (2 - c_2 \pm \sqrt{c_2^2 - 4c_3})/2$$

Since b and λ enter the equation symmetrically, it is only possible to distinguish between them on a priori grounds. In our case, it is necessary to test that the expanded expectations and adjustment model [5] is not more appropriate when using either the adaptive

expectations or the partial adjustment model since failure to do so might create serious implications. Waud (Waud 1966, 1968) has shown that, for the large sample case, the use of the adaptive expectations (or the partial adjustment) model when in fact the expanded model is the correct formulation leads to: (a) serious bias in the least squares estimate of the regression coefficients, (b) a noticeable increase in the size of the estimated standard errors relative to the estimated regression coefficients as the coefficient of adjustment, λ (or the coefficient of expectations, b) gets further away from its erroneously assumed value of 1, and (c) a very serious downward bias in the estimate for b (or λ) and hence an upward bias in the estimate of the mean lag, which becomes extremely serious as λ (or b) gets smaller. The situation would be even less satisfactory for small sample cases such as in the present study.

Thus equations [3] and]5] would form the basis for the estimated acreage equations of jute for the major producing countries. We have not introduced explicitly the changes in input prices in the equations mainly due to lack of adequate data. However, the price of rice in Bangladesh and India and other alternative crops in Thailand takes account, to a large extent, of the major elements in the costs of production of jute. Also, no demand relations have been specified in deriving the acreage equations which is based on the implicit assumption that shifts in demand and supply of jute are independent. This kind of assumption does not seem unrealistic for an agricultural commodity like jute produced under subsistence agriculture.

IV. A NOTE ON ESTIMATION

The various forms of equations considered above, describing the acreage of jute in the producing countries, all exclude current variables endogenous to the rest of the world market model of jute. Hence the equations have been estimated by the method of ordinary least squares. One of the basic prerequisites of this method is the assumption of zero correlation between all disturbance terms of diffeent periods which is often violated in the analysis of economic time series and estimation by ordinary least squares in such cases lead to inefficient estimations. Moreover, Griliches (Griliches 1961) has shown that if the true equation is of the simple form

$$ACR_t = a_1 \, p_{t-1} + u_t \qquad \qquad .. \qquad \qquad .. \ (6)$$

and if the disturbance term follows a first-order autoregressive scheme such that

$$u_t = \rho u_{t-1} + e_t$$

and, in place of (6), the distributed lag model

$$ACR_t = a_1 p_{t-1} + a_2 ACR_{t-1} + v_t \qquad .. \qquad (7)$$

is estimated, introducing the irreleveant variable ACR_{t-1}, then significant coefficients usually result with reduced serial correlation in the estimated residuals of (7), But this may be due to ACR_{t-1} in (7) acting as a surrogate for u_{t-1} in what may be the true model (6). And in cases with highly positive autocorrelation, p will be significant and so the estimated coefficient of ACR_{t-1} may appear to be positive and significant even though the basic model (7) is wrongly specified. Furthermore, the usual Durbin-Watson test for serial correlation is inappropriate for models including a lagged dependent variable as an explanatory variable. There is always a greater likelihood of autocorrelation in autoregressive models than the d-statistic test would suggest (Nerlove and Wallis 1966, pp. 235-8). Hence while we may compute the value of this statistic for all our estimated equations, we are unable to perform any statistical tests of the absence of serial correlation. However, in cases where this statistic appears to be "unusually" high or low, the equation is re-estimated by the Cochrane-Orcutt iterative procedure.

At the same time, it is also necessary to test against the possibility of price lag misspecification, even though there are strong a priori reasons for expecting lags. If model (6) does have a first order positively autocorrelated error structure, then by substituting this structure and

$$u_{t-1} = ACR_{t-1} - a_1 p_{t-2}$$

into (6), the following can be obtained :

$$ACR_t = a_1 p_{t-1} + \rho ACR_{t-1} - a_1 \rho p_{t-2} + e_t \qquad .. \ (8)$$

To indicate whether (6) or (7) is the true model, (8) can be estimated to see if the estimated coefficient of P_{t-2} is negative and significant and approximately equal to $-a_1\rho$. This would provide a rough criteria for choosing between the traditional static model and the distributed lag specification implicit in the adaptive expectations model.

V. ACREAGE EQUATION FOR BANGLADESH

Jute, as emphasized earlier, plays a major role in the economy of Bangladesh. Most of the policies of the government of Bangladesh affecting jute are either direct or indirect efforts towards stabilization of jute prices. However, most of the measures proved largely ineffective and consequently prices in Bangladesh follow inevitably the world market trends. Thus in specifying the acreage equations, no specific variables have been included for these government policy.

In addition to prices of jute and rice, the choice of other non-price explanatory variables is a difficult task. It seems impossible to use all variables in estimating acreage function, due to data limitations and multicollinearity and other associated problems. Nevertheless, based on a priori information, the desired acreage equation (1) is respecified in the following form : [10]

$$ACR_t^* = a_0 + a_1 p_t^* + a_2 RYPA_t^* + a_3 SDRAV_t + a_4 T + u_t \quad .. \quad (9)$$

and the estimating equations are obtained by the same way as described above. The expected price variable, p_t^*, has been used both in the form of a ratio between the prices of jute and rice and separately. The expected per acre yield of jute relative to yield of rice, $RYPA_t^*$, is expected to have significant influence in forming the desired acreage. One would expect a_2 to be positive under normal circumstances since increases in expected yield, *ceteris paribus*, presumably would make production of the crop under consideration more desirable. For simplicity, and given the subsistence nature of cultivation, the relative yield rate of the previous season has been taken as the expected yield rate $(RYPA_t^* = RYPA_{t-1})$.

In the economic literature it has often been emphasized that for subsistence farmers the possible rewards for returns above the expected value may not offset the severe consequences for returns below the expected value (Behrman 1968, pp. 96-7, Roumasset 1976). A crop, with small expected values and higher central moments in the subjective price and yield probability distributions may therefore be preferable to a crop for which the probability distributions have substantially higher expected values, but also larger higher central moments. Thus for subsistence farmers, characteristics of the probability distribution other than the expected values are very important in determining the desired area. In the absence of any precise and satisfactory approach, a crude representation of such variances is included in this study. The actual standard deviation of the relative acre value of jute compared to rice, $SDRAV_t$, in the three preceding years is included as a proxy for the variance of the subjective probability distribution. The selection of a three year period is, however, arbitrary. It is expected that a_3 would be negative since increased standard deviation, *ceteris paribus*, would make jute production less desirable. Finally, a time trend variable, T, has been included. A dummy variable, DUM, is introduced for the year 1971 when production was disrupted due to the indepence war of Bangladesh.

The results of the regression analysis are presented in Tables 1 and 3 for total jute acreage in Bangladesh. Equations I and II refer to the adaptive expectations model (or alternatively the partial adjustment model) as derived in (3) without the surrogate variable Z_t. The much less significant results obtained in estimating the static equation III (which is a general formulation of (6) with a constant term) lends further support that lags in the acreage equations are important. To indicate which of (6) and (7) is the true

equation, equations VI and VII (corresponding to (8)) are estimated. From equation VI, $\hat{a_1 \rho} = 291.879$ which does not approximate $\hat{a_1 \rho} = 480.734$. Similarly, from equation VII, $\hat{a_1 \rho} = 0.154$ which does not approximate $\hat{a_{1 \rho}} = 0.461$. Therefore the traditional static model is rejected in preference to the distributed lag specification implicit in equation (3). Before the ultimate choice is made, it is again necessary to test whether the expanded expectations and adjustment equation(5) is more appropriate than the other equations. Equations IV and V give the results for the expanded model, from which it apears that the acreage variable lagged two years is quite insignficanit and the fit of the regression has not improved much. Thus we reject the expanded equation in favour of the simple partial adjustment equation.

Finally, equations VIII and IX were estimated including the other variables in addition to the price variables. Our interpretation of the equation will run in terms of the partial adjustment model with "naive" expectations of price the adaptive expectations model involves lagged values for each of the additional explanatory variables other than prices, which were found insignificant. In equation VIII, the relative price of jute and rice is utilized, whereas in equation IX, they enter separately.Both yield quite similar results, the signs of all coefficients confirming a priori assumptions, except for the lagged relative yield variable. However, as pointed out earlier, this points out to the importance of rice yield for the farmers of Bangladesh. As rice is the staple food, the farmers always plan to grow enough rice for their on-farm consumption, independent of the unpredicatable prices of rice in the market. Moreover, the variable is not significant. The estimated coefficient of adjustment values of 0.431 and 0.454 demonstrate the rigidities in the relationship. Comparison of the lag with India and Thailand (in Tables 3 and 4) reveals that while significant lags are found in these countries due to the nature of the product, thelag is relatively longer in Bangladesh, perhaps because the cultivation of jute in Bangladesh has become a traditional "way of life" for so many people for so many years.

The estimated jute acreage elasticities that result from equation IX are 0.3453 for the short-run and 0.7605 for the long-run or equilibrium elasticities, with respect to jute prices. We were unable to isolate a significant price expectations effect (other than of naive expectations) in the Bangladesh jute acreage equation. However, the importance of expectations about future prices is actually already included implicity in the partial adjustment equation, for one of the behavioural factors determining the size of λ is the degree to which jute growers assume that currently observed price changes are permanent, as opposed to transitory. Looking at the other coefficients in equation IX, we find that price of rice, as expected has a negative impact on jute acreage. The risk aversion behaviour of the farmers is quite evident, and in accordance with the theory. The time trend variable, which is used as a proxy for technological and other development, has been found to be quite significant.

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TABLE 1   ALTERNATIVE FORMS OF ACREAGE EQUATIONS FOR BANGLADESH*
1950 to 1975

| Equations | Regression Coefficients (with t-values in parentheses) | | | | | | | | R^2 | DW |
	Intercept	ACR -1	ACR -2	RPR -1	RPR -2	PRJ -1	PRJ -2	PRR -1		
I	558.6 (1.46)	0.46 (3.33)		509.2 (2.28)					0.51	1.48
II	814.4 (2.31)	0.39 (2.67)				0.57 (2.28)		-0.20 (-1.83)	0.55	1.55
III	1348.5 (5.19)					0.50 (1.83)			0.35	0.72
IV	369.6 (1.89)	0.36 (2.25)	0.16 (0.43)	594.4 (2.53)					0.48	1.22
V	532.2 (1.57)	0.24 (1.34)	0.23 (0.59)			0.71 (2.79)		-0.21 (-1.88)	0.53	1.37
VI	530.4 (1.83)	0.63 (4.39)		463.3 (3.16)	-480.7 (-0.60)			-0.29	0.46	1.73
VII	1015.8 (2.75)	0.59 (3.31)				0.26 (2.19)	-0.46 (-0.76)	-1.06	0.43	1.91

* Variable definitions and data sources are in Appendix

TABLE 2 ALTERNATIVE FORMS OF ACREAGE EQUATIONS FOR INDIA*
1950 to 1975

Equations	Intercept	ACR -1	ACR -2	RPR -1	RPR -2	PRJ -1	PRJ -2	PRR -1	R²	D W
I	61.91 (1.73)	0.55 (2.43)							0.49	1.76
II	91.9 (1.79)	0.45 (2.14)		494.5 (2.03)					0.47	2.00
III	1357.8 (2.66)					1.14 (3.48)		-0.07 (-1.66)	0.42	1.52
IV	436.6 (1.49)	0.51 (2.14)	0.10 (0.79)	520.7 (2.09)		1.09 (3.03)			0.32	1.71
V	86.8 (1.12)	0.41 (2.17)	0.01 (0.08)			1.14 (3.42)			0.44	2.01
VI	311.8 (1.38)	0.80 (3.06)		367.9 (2.71)	-531.7 (-1.06)				0.45	1.97
VII	14.14 (1.42)	0.29 (1.88)				0.49 (3.33)	0.38 (0.85)		0.47	1.91

*Variable definitions and data sources are given in Appendix.

TABLE 3 ESTIMATED ACREAGE EQUATIONS FOR BANGLADESH AND INDIA[a]
1950 to 1975

Equations	Intercept	ACR -1	RPR -1	PRJ -1	PRR -1	SDR-AV	RYPA -1	FA-POP -1	T	DUM	$\bar{R}^2$	DW	ρ[b]	λ
A. Bangladesh														
VIII	501.1 (1.81)	0.57 (3.33)	665.2 (3.37)			-580.4 (1.90)	-144.7 (-0.89)		9.22 (1.74)	-489.6 (-1.84)	0.73	1.92	-0.29	0.43
IX	918.3 (1.92)	0.55 (3.44)		0.69 (3.57)	-0.55 (-3.25)	-480.4 (-1.84)	-119.3 (-0.75)		16.3 (1.88)	-554.5 (-2.19)	0.75	1.84	-0.12	0.45
B. India														
VIII	-36425.7 (-5.62)	0.29 (2.58)	1483.1 (8.82)			-846.9 (-2.01)	2617.6 (4.47)	-3.93 (5.57)	-462.5 (-4.64)		0.87	1.85		0.71
IX	-33517.9 (-2.98)	0.39 (2.27)		1.19 (3.75)	-1.41 (-3.37)	-51.56 (-1.08)	1963.7 (2.34)	3.88 (2.92)	-479.5 (-2.56)		0.71	2.51		0.60

[a]Variable definitions and data sources are given in Appendix.
[b]Estimated by Cochrane-Orcutt iterative procedure.

VI. ACREAGE EQUATION FOR INDIA

The acreage equation used for India closely resembles the one in the case of Bangladesb. However, in the case of India another variable–the farm population in the area of concern—has been added to the desired area relationship. The logic behind the inclusion of this variable is that in India, where jute acreage increased enormously after 1947 due to the government's policy of attaining self-sfficiency in jute, jute cultivation was introduced into completely new areas under government initiatives. Given the high prices of jute and the associated cash income, as the population in the area of concern increases, jute acreage is expected to increase as new land is brought under cultivation. Thus we would expect the estimated coefficient to be positive. Except for this addition, the same equations, as for Bangladesh, are estimated in the case of India. As in the case of Bangladesh, the acreage equatiors have been specined independent of the government measures for stalbilization on the assumption that effects, if any, of the measures are reflected in the market prices of the product.

The results for India are presented in Tables 2 and 3. The less significant results obtained from the simple static equation III point to the importance of lags in the behaviour of he farmers. The test in terms of equations VI and VII gives $\overset{\wedge\wedge}{a_i\rho}= 294.32$ whereas $\overset{\wedge}{a_i\rho}=531.65$ for equation VI and $\overset{\wedge\wedge}{a_i\rho}=0.142$ compared to $\overset{\wedge}{a_i\rho}=0.375$ for equation VII. Thus we reject the traditional model on the basis of this test. With respect to the expanded expectations and adjustment model, the estimated equations IV and V show that the acreage variable lagged two years is insignificant in both cases and its inclusion in no way improves the fit of the equation. Thus we may reject the expanded model in favour of the simple partial adjustment model, which is estimated in equations VIII and IX along with other variables. The results are quite significant with the signs of all coefficients in accordance with a priori assumptions. The estimated coefficient of adjustment value of 0.713, from equation VIII, demonstrates the importance of rigidities. However, as expected, these are less severe than in the case of Bangladesh.

Looking at other coefficients, the relative yield of jute compared to rice has been found quite significant and the farmers are found to be quite sensitive to the relative yield rate variable in making their decisions. Moreover, their behaviour of risk aversion is prominent and significant, so that any increase in the relative variability of returns from jute cultivation makes the production of jute less desirable. Farm population in the area has a significant positive impact on the area under jute. However, the time trend has a negative impact on acreage.

Thus it is found that jute acreage in India is more sensitive to economic factors than in the case of Bangladesh Moreover, the rate of adjustment of actual to desired jute acreage is relatively high.

VII. ACREAGE EQUATION FOR THAILAND

In Thailand, jute (including kenaf) has become one of the most important commo-
dities over the past two decades. By 1966, it ranked third after rice and rubber as an
export earner for Thailand. A considerable degree of regional specialization has develop-
ed in the case of jute and kenaf in Thailand. Jute is grown along river banks in the
Center whose production is limited due to competition with rice for land. Kenaf is
mainly concentrated in the Northeast where the land is dry and unsuitable for rice cul-
tivation. Among the upland crops, while in the late fifties and early sixties when kenaf
production rapidly expanded, maize was the main crop competing for virgin land with
kenaf in the Northeast, the picture has recently changed as less virgin land has become
available, and maize cultivation has tended to move out of the Northeast into the Central
plain where kenaf is not grown ; Kenaf now competes mainly with castor beans and
cassava and, to some extent, rice, not only for land, but also for labour (Ingram 1971,
Muscat 1966). This is in marked contrast with the pattern of jute growing in Bangla-
desh and India, where labour is plentiful. However, as in those cases, the decision to
grow more or less kenaf in any one year is also determined by kenaf prices at the previous
harvest and at the time of sowing relative to the competing crops. Availability of suffi-
cient retting water also constitutes an additional constraint on the supply of kenaf in some
years, although the fibre quality tends to be more affected by this factor than the quantity.

Based on a hypothesis similar to that adopted in the case of Bangladesh and India,
the acreage equations for Thailand are estimated and the results are presented in Table 4.
However, in this case in the absence of a single alternative crop, the weighted prices of
maize and rice were used. In the case of yield per acre, in the absence of reliable data,
the lagged yield per acre of jute was used. Regressions were run in terms of relative pri-
ces only. Equation I represents the adaptive expectations (or alternatively the partial
adjustment) model. To/ test the superiority of equations (6) and /(7) equation III was
estimated from which $\hat{a}_1\rho=35.02$ which does not approximate $\hat{a}_1\rho=70.49$. Further-
more, the results obtained from the expanded equatin II where the acreage lagged two
years turned out very insignificant justifies the use of the partial adjustment model IV.
All the coefficients in the equation are quite significant with signs corresponding to a priori
assumptions. The estimated coefficient of adjustment value of 0.702 demonstrates a
high degree of adjustment of actual to desired acreage. The time trend variable, used
as surrogate for other changes, is significant.

VIII. CONCLUSIONS

This study of jute acreage of the three major producing countries of the world has
resulted in some interesting equations. Since these equations yield quite similar results

for the countries studied, it is possible to make some general observations. First, by using a model incorporating an adjustment lag, this study shows that jute acreage is indeed quite responsive to changing economic factors. Calculated elasticities of estimated acreage equations for different countries are presented in Table 5 The estimates of elasticities of jute acreage with respect to lagged jute (or relative) prices vary from 0.3453 to 0.8205 for the short-run and from 0.7605 to 1.1688 for the long-run. The elastic nature of jute acreage to prices is, therefore, an important aspect of the world jute market. The effects of substitute products (e.g., rice) on jute acreage also are estimated to be quite high. Thus we would expect to find in jute production the strong cycles that have been observed in the production of other agricultural products.

Statistically, the estimated equations for all the countries are quite good, where serial correlation of the residuals did prove to be a problem the equations were estimated by the Cochrane-Orcutt iterative procedure. From the point of view of economic theory, the main deficiencies in all the equations is the absence of cost variatbles. A considerable amount of future ressearch is needed on the production of jute in each country if these cost factors are to be analyzed adequately, but those who undertake such research will certainly have problems in obtaining the necessary data. Another deficiency of all these equations is the lack of proper variable for technological changes which had to be approximated by the time trend variable. However, inspite of these deficiencies, these equations do seem to give the approximate structure of the jute acreage equations

The elasticity of acreage under jute with respect to price has been estimated by several authors, and a comparison of the results is summarized in Table 6. Although the other studies cover different time periods and employ different methods of analysis, the results are roughly similar. In general, the elasticities are higher in India than in Bangladesh. However, acreage under jute is found to be most responsive in Thailand. In making inter-country comparisons, it is difficult to reconcile why estimated price elasticities in India are higher than in Bangladesh, given the quite similar and comparable production conditions. It may be that prices have fluctuated considerably more in India, which will result in different coefficients than if prices had changed by equal amounts. In addition inter-country comparisons are difficult to make because the coefficients may be biased due to inaccuracy of data.

The above analysis suggests that the principal determinant of area under jute in these countries is the jute farmers' expectations of the relative price of jute compared to the alternative crops, which is largely based on the preceding year's prices. Thus it should come as no surprise that the most remote subsistence-oriented farmers of these traditional developing countries are as much economic men as their counterparts in developed countries, and are driven by motives akin to profit maximization. To quote from Behrman (Behrman 1968, p. 337) :

TABLE 4   ESTIMATED ACREAGE EQUATION FOR THAILAND*
1960 to 1975

Equations	Intercept	Regression Coefficients (with t-values in parentheses)						$\bar{R}^2$	DW	ρ^b	λ
		ACR -1	ACR -2	RPR -1	RPR -2	YPAJ -1	T				
I	-205.4 (-1.82)	0.50 (4.42)		232.2 (4.73)				0.83	2.22		
II	-211.9 (-1.81)	0.44 (2.46)	0.07 (0.39)	233.1 (4.62)				0.83	2.15		
III	-272.1 (-2.09)	0.35 (1.86)		100.2 (4.69)	70.5 (1.02)			0.84	1.95		
IV	-718.8 (-3.34)	0.30 (2.23)		321.4 (5.76)		900.7 (2.47)	20.6 (1.87)	0.90	2.21	-0.36	0.70

a Variable definitions and data sources are given in Appendix.
b Estimated by Cochrane Orcutt iterative procedure.

TABLE 5 CALCULATED ELASTICITIES OF ESTIMATED ACREAGE EQUATIONS

Country and years	Elasticity with respect to lagged price of jute		Elasticity with respect to lagged relative price of jute and rice/other commodities of interest		Elasticity with respect to lagged price of rice		Elasticity with respect to lagged yield rate of jute and rice/other commodities of interest	
	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
Bangladesh 1950 to 1975	0.3453	0.7605	—	—	-0.3320	-0.7312	-0.1101	-0.2426
India 1960 to 1975	—	—	0.7120	0.9986	—	—	0.9611	1.3480
Thailand 1960 to 1975	—	—	0.8205	1.1688	—	—	0.6475	0.9223

a. All elasticities are calculated at the mean levels of the respective time series.

TABLE 6 SUMMARY OF ESTIMATES OF PRICE ELASTICITIES OF PRODUCTION OF JUTE

Geographic Region	Time period	Short-run Elasticity	Long-run Elasticity	Dependent Variable
Bangladesh[a]	1950-1975	0.3453	0.7605	Area under jute
East Pakistan[b]	1948-1961	0.29 to 0.42	—	Area in jute or area in jute relative to alternative crop
Pakistan[c]	1949-1962	0.40	0.65	Area in jute
East Bengal[d]	1931-1953	0.60	—	Quantity
Bengal[e]	1911-1938	0.68	1.03	Area in jute relative to alternative crop
Bengal, Bihar, Orissa[e]	1911-1938	0.75	—	Area in jute relative to alternative crop
India[a]	1950-1975	0.7120	0.9986	Area under jute
India[d]	1931-1954	0.60	—	Quantity
India[c]	1951-1962	0.76	0.99	Area in jute
India (undivided)[f]	1911-1938	0.46	0.73	Area
Thailand[a]	1960-1975	0.8205	1.1688	Area under jute
Thailand[g]	1954-1963	0.88 to 5.50 Mean 2.70	1.19 to 22.45 Mean 5.75	Area in jute

a   Our estimates   e   Stern (1962)
b   Hussain (1964)   f   Venkataraman (1958)
c   Rabbani (1965)   g   Behrman (1968)
d   Clark (1957)

".......in the short run, farmers in underdeveloped countries respond rationally and substantially to economic incentives. No significant evidence, incontrast, has been found for the hypothesis thatinstitutional constraints preclude significant responses to economic incentives in underdeveloped agriculture. The burden of proof, thus now lies with those who maintain that the supply behaviorof farmers in underdeveloped agriculture cannot be understood predominantly within the faramework of traditional economic analysis."

The models of farm supply response, which was primarily developed for the developed countries, when used for the developing countries as in our study, not only do not break down, but yield plausible, interesting, and internationally comparable supply response estimates.

Notes :

1. The term 'jute' has been used throughout the paper to include other allied fibres, e.g., kenaf, roselle, etc. which are close substitutes for jute.

2. For a detailed discussion on production and other aspects of the world jute economy, see Mujeri (1978, 1979).

3. Summaries of the debate over supply responsiveness of subsistence farmers can be found in Behrman (1968), Falcon (1963), Hussain (1964), and Stern (1962).

4. For detailed discussions, see Mujeri (1978), Rabbani (1965), Clark (1957) Hussain (1964), and Stern (1962). This relationship, which has been the subject of much study as stated above, has however become increasingly weak in recent years. Despite government encouragement of rice growing and a marginal comparative advantage for jute, the farmers do not appear to have switched to rice to the extent that former statistical relationships would have suggested. In part this may be explained by the increased apperecia-tion of jute as a source of cash income whereas, atleast for subsistence far-mers, greater rice production may only lead to greater on-farm consump-sumption. However, apart from the unpredictable climatic conditions which in fact dominate the total supply situation in any given season, the jute-rice price relationship still remains the main single identifiable long term factor influencing the supply of jute in Bangladesh and India.

5. Conceptually the price level refers to the price of the crop of concern relative to the price of all other products that compete for the same resources and rela-tive to the price of all the inputs used to produce the crop.

6. Farmers' price expectations are also likely to depend on the available market information, but this factor has not been explicitly included in the model.

7. For a detailed discussion, see Johnson (1960).

8. For details of the calculations of elasticities, see Griliches (1967).

9. See Johnston (1972) For further details of the problem of estimation of distributed lags, see Liviatan (1963) and Dhrymes (1971).

10. Linear functions have been used in the study. However, if some non-linear forms are better specifications of reality, then they can be thought as approximations (the first term of a Taylor expansion of the particular non-linear forms).

11. However, a negative value for expected yield is also plausible If the farmers' goal is to maximize cash income from jute subject to the constraint that sufficient rice for his subsistence consumption has to be grown, then an increase in the expected relative yield as defined, ceteris paribus, might result in a decrease in the desired area under jute.

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