The Economic Journal of Nepal, Vol.11, No.4, Issue 44, October-December 1988 © DOE-TU

Farmers' Supply Response and its Implication to the Price Support Policy in Nepalese Paddy Sector

KRISHNA BAHADUR HAMAL*

INTRODUCTION

Paddy is one of the major foodgrain crops in Nepal occupying about 50 percent of the total cropped area and 55 percent of the total cereal cropped area. In 1984/85 about 1.38 million hectare were covered by paddy production. Moreover, paddy constitutes 47 percent of the total per capita consumption of foodgrains and it together with wheat and maize provides 80 to 85 percent of the total calorie intake. In addition to this, paddy which is considered as traditionally most important export commodity together with maize, wheat, millet and barley accounts about 40 percent of agricultural GDP.

Realising such an importance of paddy in Nepalese agricultural sector, the government of Nepal has been giving top priority to the policies and programmes that lead to increase production and productivity of paddy in order to meet its internal requirement and to build up an exportable surplus to cope up with the problem of declining foreign currency reserves. Among these, the paddy price support policy is one that is aimed to stimulate farmers to increase their paddy production within the existing production function and within a short period.

The paddy price support policy which is one of the major elements of Nepalese agricultural pricing policy was first introduced in 1976/77 by announcing a minimum support price (MSP) for coarse paddy. The MSP was defined as that price below which market price is not allowed to go downward. Since then, the MSPs for coarse paddy were continuously announced except in the year 1979-80. However, results of the MSP policy in Nepal have been disappointing from the very beginning. Evidence shows that the productivity and production of paddy have remained almost stagnant during the period of 1976/77 to 1984/85. Several reasons that are mostly related to administrative and financial aspects have been cited for such ineffectiveness of the MSP policy. However, the most concerning reason, which is believed to be the farmers' supply behaviour, has been always neglected by decision makers in their policy decisions.

In the literature of the price support policy, it is generally believed that the price support policy could convince each individual farmers that prices would not be allowed to fall below reasonable level and, would, therefore, offer an incentive to them to increase their production.

---

*Mr. Hamal is a Senior Economist at the Agricultural Projects Services Centre (APROSC), Kathmandu, Nepal.

Moreover, the price support policy also reduces risk and uncertainty arising out of seasonal price fluctuations and improves the farmers' expectations regarding market prices which in turn determine their production decisions. However, the major objective of the MSP policy to increase paddy production and productivity will be fulfilled only when majority of farmers are price responsive. Therefore, farmers' supply behaviour with respect to a change in paddy price has a greater role to make the MSP policy successful. Thus, this study has been carried out to analyse farmers' supply behaviour with respect to a change in paddy supply price.

Further, Nepal is divided into three geographical regions viz. mountains, hills and Terai. Paddy is produced only in the hills and Terai. Farmers in the hills are subsistence, traditional and non-market oriented, and produce paddy for their own consumption. On the other hand, farmers in Terai where markets are well developed are believed to be relatively more commercialised. Therefore, supply elasticities in Terai are likely to be higher than the supply elasticities in the hills. This hypothesis has also been tested in this study.

The study has also explored any change in value of supply elasticities as a result of structural change measured in terms of time variable. In other words, it is likely that farmers' price responsive behaviour may change in an interval of each 10 years or so, as a result of socio-economic development in the country. That is, as farmers become more educated and market oriented with the economic development of the country, it may affect their price responsive behaviour with respect to crop they grow. Thus, this study which examines these issues seems to be useful to the researchers and the policy decision makers, especially to those who are directly involved in the MSP policy decision making.

DATA

The data used in this study are the secondary time-series data published in the Agricultural Statistics of Nepal: 1983 and 1985, by the Department of Food and Agricultural Marketing Services, His Majesty's Government of Nepal. The data used in this study cover the period 1961/62 to 1984/85. Moreover, data on prices are also used from the Monthly Bulletin of Nepal Rastra Bank, a publication of the Central Bank of Nepal.

REVIEW OF SUPPLY RESPONSE MODEL

The history of the price expectation hypothesis is much more older than Nerlove's supply response model. It started with the development of cobweb model which nicely incorporates the idea that producers are influenced solely by the most recent season's prices and, that price expectations are that this last season's price will prevail in next period. However, the cobweb model is considered to be naive in more than just formulation of price expectations. Later a more shophisticated adaptive expectations model was developed by Goodwin, who hypothesized that the present price is equivalent to the actual price in the last period plus (or minus) some proportion of the change in actual price between last year and two periods ago. Mathematically, the relationship was presented as:

(1) $$P_t^1 = P_{t-1} + \beta(P_{t-1} - P_{t-2})$$

where P_t^1 = expected price in period t and P_{t-1} = actual price in period t-1 and so on. Like cobweb model this model is also considered to be naive in the sense that farmers do carry short memories.

It is only in early sixties that the work of Koyck introduced a more satisfactory approach to expectations. In his distributed lag model, Koyck allowed past experience to be of infinite duration and also placed heavy weights on more recent information considering a relationship that holds between output and prices in following way:

(2) $$Q_t = \alpha P_{t-1} + \alpha\lambda P_{t-2} + \alpha\lambda^2 P_{t-3} + \dots\dots\dots\dots$$

where $0 < \lambda < 1$. The equation can be further deduced as:

$$Q_t - \lambda Q_{t-1} = \alpha P_{t-1}$$

$$\text{or,}\quad Q_t = \alpha P_{t-1} + \lambda Q_{t-1}$$

(3) $$\text{or,}\quad \Delta Q_t = Q_t - Q_{t-1} = \alpha P_{t-1} + (\lambda - 1) Q_{t-1}$$

where α indicates the short-term responsiveness to prices, $\alpha/(1-\lambda)$ gives the long-term equilibrium response and λ is the coefficient of adjustment. As $\lambda \to 1$, the cultivators' adjustment process will tend to be slower and, as $\lambda \to 0$, the adjustment process will tend to be faster.

Several modification has been done with this basic distributed lag expression depending upon the maturity duration of crop (such as perennial crops). Since this study deals with crops that have maturity duration less than a year, therefore, the study does not discuss the distributed lag and weighting methods beyond this point.

CRITICAL REVIEW AND CHOICE OF SUPPLY RESPONSE MODEL

Marc Nerlove's adaptive expectations model which became very popular in estimating supply price elasticities in agriculture production contains three major components that explains farmers' supply responsiveness with respect to changes in prices. These are:

a. the effect on price expectations of changes in current price;

b. the effect of changes in expectations on long-run equilibrium output; and

c. the effect of changes in long-run output in current output.

The first component is related to the elasticity of expectation. Based on the Hicksian concept of elasticity of expectation, Nerlove derived an expression of price expectations as follows:

(4) $$P^1_t = P^1_{t-1} + \beta(P_{t-1} - P^1_{t-1})$$

Here it is assumed that an expected 'normal' price (P^1_t) does exist for the producers at any point of time, and it is expressed as last period's expected 'normal' price plus (or minus) some degree of adjustment upon the elasticity of expectation and last period's actual price. The coefficient of expectation (β) is constant. If β is zero, actual prices are totally divorced from expectations and; if β is unitary, expected prices are identical with last year's realised price.

Moreover, by rewriting above expression in the form given below, one can see how it represents a moving average of past prices with the weights declining the farther back in time.

(5) $$P^1_t = \beta P_{t-1} + (1-\beta)P^1_{t-1}$$

With few simplifying assumptions, this first order difference equation can be solved in terms of t, P^1_t and β as:

(6) $$P^1_t = \sum_{N=o}^{t} \beta(1-\beta)^{t-N} P_{N-1}$$

It indicates that the expected 'normal' price is the weighted average of past prices. For $0 < \beta < 1$, the weights attached to past prices will go on declining as one moves back in time. This is same form as Koyck's distributed lag that was discussed earlier.

The second component which deals with the effect of changes in expectations on-long run equilibrium is required to establish a relationship between two variables Q^1_t and P^1_t which are unobservable. Assuming $\beta < 1$ and $\gamma=1$ Nerlove established a relationship between Q^1_t and P^1_t. through following equation:

(7) $$Q^1_t = a_o + a_1P^1_t + a_2 Z_t + U_t$$

where Z_t is a relevant and observable non-market variable whose presence is required to solve the problem of parameter identification (i.e. distinguishing β from γ). Moreover, Z_t must enter in the model nonsymetrically.

The third component is related to long run adjustment to changes in price expectation. Nerlove considers the short run supply elasticity must be less than or equal to the long run elasticity. It is because as the farmers get more time to adjust their output, the more options they get to change their inputs. Based on this notion, Nerlove developed an expression to show a relationship between the actual output (Q_t), long-run equilibrium output (Q^1_t) and time.

(8) $$Q_t - Q_{t-1} = \gamma(Q^1_t - Q_{t-1})$$

where Q_t^1 itself changes over time and, γ is a constant which denotes the area adjustment coefficient. Further, the equation can be rewritten in the form of first difference equation and then solved for Q_t with some manipulation as follows:

(9) $$Q_t = \gamma Q_t^1 + (1-\gamma)\, Q_{t-1}$$

(10) $$Q_t = \sum_{N=o}^{t} \gamma(1-\gamma)^{t-N} Q_N^1$$

This is same form as Koyck's distributed lag model. If $\gamma=0$, output is unchanged from year to year; if $\gamma=1$, area adjustment is complete in a single time period.

Thus, with equations (4), (7) and (8) Nerlove developed the supply response model to analyse how a change in price lead to a change in output. Further, these equations reduce into a single equation that makes estimation of parameters more easier.

However, the Nerlovian model also suffers from criticism. Muth, in his hypothesis of rational expectations, argues that the mechanism of formulating implied adaptive expectations in the Nerlovian model is theoretically inconsistent with the farmers' supply decision in the model. In other words, though the supply equation of the Nerlovian model describes farmers' rational behaviour with respect to a change in output and input prices, it ignores the available information which will affect the future trend of prices. On the other hand, the rational expectations hypothesis considers that economic agents do not waste information and their expectations are basically the same as predictions based on economic theory. That is, the rational expectations model is believed to be consistent with the notion that farmers are optimizers. However, the model of rational expectations has also been criticized by several researchers namely DeCario and Friedman. According to these writers, the perceptions of farmers are likely to differ in learning the true underlying structure of market. This learning may become more difficult and complex in a traditional agriculture where majority of farmers are illiterate and isolated from the market mechanism (or structure). In such a situation, the rational expectations model may not be an appropriate model to examine farmers' responsive behaviour with respect to a change in supply price. Therefore, in this study the use of a modified adaptive expectations model is emphasized. Moreover, by using an adaptive expectations model, results can be directly compared to past studies of other countries because most of the past studies of this nature have relied on an adaptive expectations model.

In addition to the above criticism, there are several other controversies that surround the use of the Nerlovian model. The major ones are discussed here. First, controversy lies in the choice of the dependent variable - whether output or acreage should be used as dependent variable in model. However, a majority of researchers believe that the basic relationship between expected prices and cultivator reactions could be bettèr expressed in terms of planted and harvested acreage rather than in terms of harvested tonnage. Therefore, this study also uses acreage as the dependent variable in the model.

Second, equation (7) simply indicates that desired output is a function of expected price. But then the question arises what price variable should be included in the model. Different researchers have used different type of prices depending upon the nature of problems they were dealing with. The actual price of crop received by farmers may be used to represent general behaviour of farmers, whereas the ratio of actual price of crop received by farmers to some consumer price index may become more meaningful when farmers try to increase output to keep their own consumption of the given crop the same, in the face of rising input costs. Similarly, the ratio of actual price to some index of input prices (or prices of competitive crops) is more relevant when farmers aim to buy more of other goods or keep their consumption of other goods the same in case of an increase in the relative price of such a good.

Since most Nepalese farmers are small land holders (with an average area of land less than one hectare) and produce more paddy to increase their own consumption level, they are less likely to respond to a change in prices of such crop. Therefore, the study uses the price actually received by farmers in analysing their supply price response behaviour.

Lastly, there exists some problem of estimation relating to Nerlove's model. Generally, these problems were observed in past studies while using least square techniques of estimation. The major problem is that the residuals are likely to be serially correlated, therefore, the estimators will be inefficient even in the absence of the lagged value of the dependent variable and inconsistent when the equation contains lagged values of the dependent variable. Besides, the equation is overidentified as the parameters of the model can be recovered in more than one way. However, the problem of efficiency and consistency can be solved by maximizing the likelihood function of the observation with respect to above parameters. At the maximum value of log likelihood function, the sum of the square residuals is minimized, therefore, the consistent, asymptotically unbiased and efficient estimates of the parameters can be obtained. Lahiri and Roy have used maximum likelihood estimation procedure to obtain efficient and consistent estimates in their model. In addition to these researchers, there are several other researchers such as Askari and Cummings, Lee and Helmberger who have modifed and used the traditional adaptive expectations model while analysing supply behaviour of farmers. That is, the modified Nerlovian adaptive expectations model is still a valid model to examine farmers' response behaviour with respect to a change in supply price. Therefore, the model has been selected for use in this study.

MODEL OF ESTIMATION

The standard modified Nerlovian adaptive expectations model used in this study is:

$$A_t^o = a_o + a_1 P_t^o + a_2 W_t + U_t \quad (11)$$

(12) $P_t^o = P_{t-1}^o + \beta(P_{t-1} - P_{t-1}^o)$

(13) $A_t = A_{t-1} + \gamma(A_t^o - A_{t-1})$

where, A_t = actual area under cultivation at time t, A_t^o = area desired to be under cultivation at time t, P_t = actual price at time t, P_t^o = expected price at time t, W_t = weather index (rainfall in mm per year) in time t, and β and γ are termed the expectation and adjustment coefficients respectively. The reduced form of the above model is obtained as:

(14) $$A_t = a_o\beta\gamma + a_1\beta\gamma P_{t-1} + a_2\gamma W_t + a_2\gamma(1-\beta)W_{t-1} + [(1-\beta) + (1-\gamma)]A_{t-1} - (1-\beta)(1-\gamma)\, A_{t-2} + \gamma U_t - \gamma(1-\beta)\, U_{t-1}$$

(15) or, $A_t = B_1 + B_2P_{t-1} + B_3W_t + B_4W_{t-1} + B_5A_{t-1} + B_6A_{t-2} + V_t$

(where, $B_1 = a_o\beta\gamma$, $B_2 = a_1\beta\gamma$, $B_3 = a_2\gamma$, $B_4 = a_2\gamma(1-\beta)$, $B_5 = (1-\beta) + (1-\gamma)$,

$B_6 = -(1-\beta)(1-\gamma)$ and $V_t = \gamma U_{t-\gamma}\ (1-\beta)U_{t-1})$

Further, the model is used to derive short-run and long-run price elasticities of paddy supply as follows:

Short-run elasticity = $B_2{}^*(\bar{P}_{t-1}/\ \bar{A}_t)$

Long-run elasticity = (Short-run elasticity)/$(1-B_5- B_6)$

AGGREGATE ANALYSIS: NEPAL

The estimated model is:

(16) $$A_t = \underset{(126.61)}{387.990} + \underset{(21.58)}{69.074}\ P_{t-1} + \underset{(0.019)}{0.027}\ W_t - \underset{(0.019)}{0.068}\ W_{t-1} + \underset{(0.171)}{0.338}\ A_{t-1} + \underset{(0.144)}{0.276}\ A_{t-2}$$

$n = 22$; $R^2 = 0.96$; $\bar{R}^2 = 0.94$

According to two-tailed t-test, the estimated intercept and coefficients of P_{t-1}, W_{t-1} and A_{t-1} are significant at 5 percent level of significance, whereas coefficients of A_{t-2} and W_t are significant respectively at 10 and 20 percent level of significance. The overall estimated model is observed to be significant on the basis of computed values of $\bar{R}^2$ and F (= 69.23). Moreover, the study has applied following statistical tests to validate the significance of the model.

Autocorrelation Test

Since the model in this study contains lagged dependent variables on the right side of the equation, general Durbin-Watson d-statistics will not be relevant to test the presence of autocorrelation in the model. In case of D-W test, the combination of a lagged dependent variable and a positively autocorrelated disturbance term will bias the d-statistic upward and thus give misleading indications. Further, Durbin's h-test is also not applicable to test the autocorrelation problem in this study, because the h-test has some limitations in the sense that it is more appropriate in case large sample (asymptotic) and, it tests only the significance of a single autocorrelation coefficient. It does not indicate the significance of second or third order autocorrelation in the model. Therefore, Breusch Godfrey (BG) test, which is more general test and tests any kind of autocorrelation, has been used in this study. Since calculated BG (= 5.716) $< X_2^{*2}$ (= 5.991) at 5 percent level of significance, the evidence of autocorrelation is not found in the estimated model.

Heteroscedasticity

Though the problem of heteroscedasticity is generally observed in cross-sectional data, it is also likely to present in time series data. The rainfall variable seems to contain the problem of heteroscedasticity, because the variance in acreage is likely to increase with an increase in rainfall. Therefore, the most appropriate tests, such as the Goldfeld-Quandt test and the Breusch-Pegan test, were used to detect the presence (or absence) of heteroscedasticity in the model. Results of these tests indicate the absence of the heteroscedasticity in the model.

Multicollinearity Test

Since the model included in this study contains two lagged dependent variables on the right hand side of the equation, a problem of collinearity is expected. Therefore, three different tests have been used to confirm the presence of collinearity in the model.

The coefficients of correlation between each pair of explanatory variables confirms the presence of collinearity between variables A_{t-1} and A_{t-2} (r = 0.91). However, this is a crude method of detecting collinearity because the critical value (r = 0.90) imposed in the test is very subjective. Moreover, the test does not detect collinearity between more than two variables. Therefore, auxiliary regression method has been used to test the collinearity problem in the model. The test again confirms the presence of collinearity between variables A_{t-1} and A_{t-2}. When A_{t-1} was regressed on all other explanatory variables, the estimated values for R^2 and F are observed to be 0.89 and 35.84 ($> F_{4,17}$ = 2.96 at 5 percent level of significance) respectively. Similarly, when A_{t-2} was regressed on all other explanatory variables, the estimated valus for R^2 and F appeared to be respectively 0.84 and 22.58 ($> F_{4,17}$ = 2.96 at 5 percent level of significance). Further, the problem of collinearity is also confirmed by the determinant value of the correlation coefficient matrix of explanatory variables [|correl(x'x)| = 0.00097].

In the very beginning, the problem of collinearity has been tried to minimize by reducing the number of lagged dependent variables on the right side of the equation. Any further reduction in the lagged dependent variables is not possible in the sense that more reduction may violate the behavioural assumption of the model itself. Moreover, the estimated coefficients are already significant, therefore, resolving the problem of collinearity will rather increase the significancy level of those coefficients. The only major consequence of the problem is that the coefficients of these variables are likely to differ from their true values. However, it has been argued that the OLS estimators with several lagged dependent variables as regressors will be consistent and efficient, if the disturbance term is serially independent. Since the problem of autocorrelation is not present in the estimated model, therefore, the model has been accepted for further analysis in this study.

Besides, the functional form (that is, the linearity) of the model is not rejected when loglikelihood ratio (LR) test was used. During the test, the equation (16) was considered as restricted model while Box-Cox (BC) and Box-Cox Extended (BCE) models were used as unrestricted ones. When restricted model is tested against BC, the LR = 2* (lnL(BC)-lnL(H_o) = 0.196 $<$ X_1^{*2} (= 6.635), therefore, the model in equation (16) is not rejected at one percent level of significance. Similarly, the conclusion remained same when the model was tested against BCE at one percent level of significance.

Further, a Chow test was conducted to see the structural change at year 1973 and 1974. The computed value for $F_{6,6}$ at year 1973 and 1974 are respectively 0.598 and 0.204 which are less than the critical value (= 3.22) at 5 percent level of significance, therefore, there has not been any structural change in paddy sector.

Thus, the model presented in equation (16) is statistically valid to analyse farmers' supply behaviour with respect to a change in the output price. The above model is further used to estimate values of β and γ. As mentioned in earlier section, the equation is overidentified in the sense that a's, β and γ in equation (15) can be estimated in more than one way. Nevertheless, such problem has been overcome by considering following two conditions into the estimation procedure that:

(a) $|(1-\beta) + (1-\gamma)| < 1$ which is the sufficient condition for covergence of the adjustment process; and

(b) $0 < \beta < 1$, that is, the coefficient of expectation must lie between 0 and 1 to be economically meaningful.

Since $B_5 = (1-\beta)+(1-\gamma) = 0.388 < 1$, the above first condition is satisfied. Using this equation together with equation $B_6 = -(1-\beta)(1-\gamma) = 0.276$, two values for $\hat{\beta}$ are observed (i.e. $\hat{\beta} = 0.246$ or 1.366. Since the first value satisfies the above second condition, therefore, this value has been further used to estimate other remaining parameters and elasticities. The estimated parameters and elasticities are given in Table 1.

RÈGIONAL ANALYSIS: HILLS

The model given in equation (15) is estimated using data from the hilly region of Nepal. The estimated equation is:

$$(17)\ \hat{A}_t = 13.606 + 2.208\ P_{t-1} - 0.005\ W_t - 0.012\ W_{t-1} + 0.979\ A_{t-1} + 0.118\ A_{t-2}$$
$$(24.37)\quad (5.98)\quad (0.009)\quad (0.008)\quad (0.313)\quad (0.381)$$
$$n=22;\ R^2=0.96;\ \bar{R}^2=0.95$$

Since the estimated parameters except for W_{t-1} and A_{t-1} are statistically insignificant and value for $R^2(=0.96)$ is relatively high, the presence of multicollinearity is suspected. Therefore, all the tests that were used in aggregate analysis were also used to detect the presence of collinearity problem. The tests relating to the coefficients of correlation ($r \geqslant 0.90$), determinant of correlation coefficient matrix of all explanatory variables (=0.00003) and auxiliary regressions confirmed the presence of multicollinearity between variables P_{t-1}, A_{t-1} and A_{t-2}.

As discussed earlier, on the basis of behavioural assumptions these variables can't be droped out as such to overcome the problem of multicollinearity. Moreover, additional data on all these variables are not available even if we assume the additional data may contain less collinearity. And no independent relevant study (time-series or cross-sectional) is available to feed its estimated parameters for those collinear variables. Therefore, the only alternative left is to see whether there has been any structural change that might have caused high level of standard error in the estimated equation. The Chow tests were conducted at two different points of time viz. 1973 and 1974.

At year 1973, the computed $F_{6,10}$ (=1.299) $<$ F^*(=3.22) at 5 percent level of significance, therefore, the null hypothesis is not rejected in favour of no difference in estimated parameters between those two periods. Similarly, at year 1974, the computed $F_{6,10}$ (=1.843) $<$ F^*(=3.22) again confirmed no change in estimated parameters between those two periods. Thus, it is difficult to improve the quality of OLS estimates in equation (17). Moreover, the OLS estimators becomes inconsistent in presence of autocorrelated disturbance term. Therefore, the presence of autocorrelation is tested in the estimated equation using most relevant tests.

The most relevant test, that is Durbin's h-test, could not be used here as a result of $n.var(B_5) > 1$, therefore, an equivalent procedure developed by Durbin was used to test the autocorrelation problem. According to this test procedure, OLS residuals e_1 from the original model was regressed on e_{1-1} and all other explanatory variables. Since the t-value for the estimated coefficient of e_{t-1} in this regression ($|2.162|$) $> t^*_{14}$ (=2.145) at 5 percent level of significance and at two tailed test, therefore, the presence of first-order autocorrelation is confirmed. Moreover, the Breusch-Godfrey test, which shows that $BG=nR^2$ (=9.557) $> X^{*}42_2$(=5.991) at 5 percent level of significance, further concludes the presence of auto-correlation in the equation.

Thus, in presence of autocorrelated disturbances, the OLS estimators are likely to be inconsistent. Therefore, instrumental variable method, which is more relevant than maximum likelihood method in case of simple linear model, is used to obtain consistent estimators. According to this IV method, all explanatory variables (including constant) are used as their own instruments except $\hat{P}_{t-1}$, $\hat{A}_{t-1}$ and $\hat{A}_{t-2}$ are used instruments for P_{t-1}, A_{t-1} and A_{t-2} respectively considering that the instrument variables are highly correlated to their respective variables and uncorrelated with error term. The estimated equation is given in (18).

$$\text{(18)}\quad \hat{A}_t = 163.49 + \underset{(120.7)}{45.951}\, P_{t-1} - \underset{(0.064)}{0.019}\, W_t - \underset{(0.094)}{0.042}\, W_{t-1} - \underset{(13.34)}{3.398}\, A_{t-1} + \underset{(11.43)}{3.708}\, A_{t-2}$$

$$(443.2)$$

$$n = 21;\ R^2 = 0.19;\ \bar{R}^2 = -0.08$$

All of the estimated coefficients are observed to be insignificant and R^2 value is very low. One of the possible interpretation of such result is that the hilly farmers are subsistence farmers and grow paddy for their own consumption, therefore, the explanatory variables considered in the equation have no effect what so ever on their area of paddy cultivation. The finding remained same even if the sample was divided between two subsamples at year 1975.

Further, the Goldfeld-Quandt test showed that there is no heteroscedasticity in the estimated model.

REGIONAL ANALYSIS: TERAI

The model given in equation (15) is estimated using data from the Terai region of Nepal. The estimated regression equation is:

$$\text{(19)}\quad \hat{A}_t = 996.770 + \underset{(151.7)}{184.530}\, P_{t-1} - \underset{(0.145)}{0.041}\, W_t - \underset{(0.140)}{0.025}\, W_{t-1} - \underset{(0.284)}{0.057}\, A_{t-1} - \underset{(0.279)}{0.018}\, A_{t-2}$$

$$(592.5)$$

$$n = 22;\ R^2 = 0.12;\ \bar{R}^2 = -0.15$$

Unlike above two cases, there is no multicollinearity problem in this estimated model. The coefficients of correlation between each pair of explanatory variables are observed to be lower than 0.47, and the determinant of the coefficient of correlation matrix of all explanatory variables is 0.17. Moreover, auxiliary regression estimation of each explanatory variables on all other explanatory variables showed low values for R^2 ($<$ 0.37) and F ($< F^*_{4,17} = 2.96$ at 0.05 level). Thus, absence of collinearity problem is confirmed in the estimated equation.

Test for heteroscedasticity were also carried out in the estimated equation. Both the Goldfeld-Quandt test and Breusch-Pegan tests on different forms of suspected variable W_t confirmed the absence of heteroscedasticity in the model.

Regarding the autocorrelation test, Durbin's h-test could not be used due to $n.var(\hat{B}_5)=1.774>1$. However, when an equivalent procedure as discussed earlier was carried out, the absence of autocorrelation is confirmed at 5 percent level of significance.

Despite of the absence of all these estimation problems, the estimated coefficients are observed to be insignificant even at a 10 percent level of significance. Therefore, structural change between some point of time was suspected. To confirm such hypothesis, a Chow test was repeatedly conducted dividing the sample into two sub-samples at different point of time viz. 1973, 1974, 1975 and 1976. The computed $F_{6,10}$ values at these different point of time are observed respectively to be 0.513, 0.554, 0.910 and 1.20 which are less than the $F^*_{6,10}$ (=3.22). Therefore, the absence of structural change is confirmed at 5 percent level of significance. However, the OLS estimation during the period 1963 to 1975 shows highly significant coefficients indicating some relationship between explanatory variables and area of paddy cultivation. Therefore, this equation, which is presented in (20), is further used to estimate short run and long run price elasticities which are presented in Table 1.

$$(20)\ \hat{A}_t = \underset{(121.2)}{256.170} + \underset{(28.83)}{48.910}\ P_{t-1} + \underset{(0.016)}{0.018}\ W_t - \underset{(0.018)}{0.055}\ W_{t-1} + \underset{(0.227)}{0.423}\ A_{t-1} + \underset{(0.159)}{0.344}\ A_{t-2}$$

$n=13,\ R^2 = 0.95;\ \bar{R}^2=0.91$

SUMMARY AND CONCLUSION

Though the results of aggregate analysis suggest that the overall Nepalese farmers do respond to a change in supply price of paddy, the regionwise analyses indicate that farmers only in Terai do respond to such change in supply price but not farmers of hills. One of the possible reason is that farmers in hills where market is undeveloped are relatively more traditional and poor who produce paddy for their own consumption, therefore, they are less likely to respond to a change in output price of paddy. On the other hand, in Terai where market infrastructure are well developed and farmers are relatively more commercialised, it is expected that farmers will respond to a change in output price. As expected, the estimated supply price elasticity is higher in long run than in short run (Table 1) because as farmers get more time to adjust their output, the more options they get to change their inputs. The estimated elasticities imply that an increase of 10 percent in paddy price will increase the overall area of paddy cultivation in Nepal by 0.85 percent in short run and 2.52 percent in long run. These results also suggest that paddy price support policy in hills will be virtually ineffective to increase the paddy production through price mechanism. Such policy can be implemented in Terai but the decision maker should be aware of the cost and benefit of such policy because the supply elasticities are very low which may induce higher cost in implementing such policy. Thus, it may be concluded that the farmers in very traditional system, such as in Nepalese hills, do not respond to a change in output price. Even if they respond to such a change in price their degree of responsiveness will be very low such that it becomes more difficult to get the desired level of

Table 1
Estimated Coefficients of Area Adjustment, and Price Expectations and Supply Price Elasticities in Paddy, Production

Country	Year	Coefficient of Area Adjustment (γ)	Coefficient of Price Expect. (β)	Supply Price, Elasticities S-Run	L-Run
Nepal	1963-84	1.366	0.246	0.085	0.252
- Terai	1963-75	1.041	0.165	0.052	0.225
- Hills	1963-84				
Thailand[1]	1937-63	1.600	0.247	0.18	0.43
India[2]					
- Punjab	1950-66			0.03	0.05
- Madras	1946-67			0.08	0.08
- Assam	1950-67			0.07	0.07
- Mysore	1951-67			0.06	0.07
Pakistan[3]	1949-68			0.12	0.17
Bangladesh[4]	1950-68			0.13	0.19
Philippines[5]	1948-64			-ve	-ve

1. Behrman (1968); 2. Cummings (1975a); 3. Cummings (1975b);
4. Cummings (1974); 5. Mangahas and et al. (1966)

results from price support policy. In addition to this, it is also concluded that Nepal should opt for different pricing policy each for hills and Terai.

A cross country comparison of estimated elasticities indicates that estimated parameters in this study are consistent with those obtained in different studies from different countries. Moreover, the estimated elasticities are very similar to those obtained for Indian states. It is because the socio-economic conditions between these states of India and Nepal are very similar. Thus, results obtained in this study are consistent with other studies, therefore, it can be used by policy planners in their decisions regarding to paddy price support policy.

Regarding to structural change, the results obtained in earlier sections indicate that there has not been any structural change in Nepalese paddy sector. That is, changes in Nepalese paddy sector is not significant to change farmers' price responsive behaviour with respect to output supply. Therefore, the structure of paddy sector needs to be changed through education, market infrastructural development and other related programmes prior to implementing paddy price support policy.

In sum, if Nepalese policy decision makers' objective is to increase paddy production in short run, then they should look for policies other than the price support policy, because the response to the price support policy seems to be very small in Nepal to increase total paddy production.

SELECTED REFERENCES

APROSC (1982), A Study on Agriculture Primary Marketing and Procurement System in Nepal, Agricultural Projects Services Centre, Nepal.

APROSC (1985), A Study on Crop Productivity in Nepal, Agricultural Projects Services Centre, Nepal.

Askari, H. and J.T. Cummings (1976), Agricultural Supply Response: A Survey of the Econometric Evidence, New York: Praeger Publications.

Behrman, Jere (1968), Supply Response in Under Developed Agriculture: A Case Study of Four Major Annual Crops in Thailand, 1937-63, North-Holland, Amsterdam.

Cummings, J.T. (1974), "The Supply Response of Bangalee Rice and Cash Crop Cultivators", Bangladesh Development Studies, 2 (October).

---- (1975a), "The Supply Responsiveness of Indian Farmers in the Post Independence Period", Indian Journal of Agricultural Economics, 30.

---- (1975b), "Cultivator Responsiveness in Pakistani Cereal and Cash Crops", Pakistan Development Review, 14 (August), DeCario, S.

---- (1979), "Rational Expectations and Learning from Experience", Quarterly Journal of Economics 37, 47-57.

Durbin, J. (1970), "Testing for Serial Correlation in Least Squares Regression When Some of the Regressors are Lagged Dependent Variables", Econometrica 38, 410-21.

Friedman, B. (1979), "Optimal Expectations and the Extreme Information Assumptions of Rational Expectations' Macromodels", Journal of Monetary Economics 5, 23-41.

Goodwin, R. (1974), "Dynamic Coupling with Special Reference to Markets Having Production Lags", Econometrica 15.

Johnston, J. (1984), Econometric Methods, McGraw-Hill Book Company.

Kmenta J. (1986), Elements of Econometrics, Second Ed., New York: Macmillan Publishing Company.

Koyck, I.M. (1964), Distributed Lags and Investment Analysis, Amsterdam: North-Holland.

Lahiri, K. and P. Roy (1985), "Rainfall and Supply Response", Journal of Development Economics, 18, 315-34.

Lee, D. and P. Helmberger (1985), "Estimating Supply Response in the Presence of Farm Programs", American Journal of Agricultural Economics 52, 193-203.

Mangahas, M., A.E. Recto and V.W. Ruttan (1966), "Price and Market Relationship for Rice and Corn in Philippines", Journal of Farm Economics 48(3), Part I, 685-703.

Muth, J. (1961),"Rational Expectations and the Theory of Price Movements", Econometrica 29, 315-35.

Nerlove Marc (1956), "Estimates of Supply of Selected Agricultural Commodities", Journal of Farm Economics 38(2), 496-512.

---- (1958a), "Distributed Lags and Estimation of Long-run Supply and Demand Elasticities: Theoretical Consideration", Journal of Farm Economics 40(2), 301-31.

---- (1958b), The Dynamics of Supply: Estimation of Farmers' Response to Price, Baltimore: John Hopkins University Press.

Nerlove Marc and K.F. Wallis (1966), "Use of the Durbin-Watson Statistics in Inappropriate Situations", Econometrica 34, 235-38.