CHAPTER II

THE GAPS IN THE PREVIOUS STUDIES ON SUPPLY RESPONSE

Agricultural supply analysis is an area of agricultural economics research explored by many researchers for more than sixty years but pursued with great vigor during the 1960's. With the same vigor, the theories of agricultural supply response have been tested with slight modifications in the agriculture of underdeveloped countries during the 1960's and 1970's. However, little attention has been given to the changes taking place in agriculture while modifying the theories of producer behaviour.

The studies in the field of supply response have come out with different views with respect to the nature of supply response in agriculture. They have come out with complexity of results, showed difference in the price responsiveness between countries, between regions within the same country, between crops and between the period of study. The studies in the developed counties in general have come out with higher price responsiveness of farmers than the studies in the underdeveloped countries. Generally, individual commodity studies have revealed higher price responsiveness in the case of commercial crops than food crops. The studies made in the earlier past, in general have
come out with non-price response or little price response of farmers. However, the studies made in the recent past have showed increased price responsiveness in their result. The studies have used different methods, models with varying specifications in analysing the price responsiveness. They have been made at different levels - micro and macro level, aggregate and disaggregate level, production and marketing stage. They have made different assumptions. Due to one or the other reasons, important influencing variables were either ignored or assumed to remain constant. All these taken separately might have contributed for the difference in the price response result. In view of the confusion existing with respect to the nature of supply response and severe problem agriculture continues to face in adjusting supplies to increased market demand, the supply response analysis is still the need of the hour.

Before proceeding further on an attempt to estimate supply elasticities for agriculture, it becomes very important to make a survey of the previous studies on supply response in order to have a better understanding of the problem, methodological details and to identify the gaps in the previous studies. This can be accomplished only by making an appropriate classification of the studies made up to date.

The body of literature on supply response can be classified into various categories on the basis of different
attributes. On the basis of countries of origin, the studies can be divided into two general categories viz., (1) studies made in developed countries and studies made in developing countries. On the ground of the nature of supply dealt with, the studies can be grouped as (1) Market supply response studies—studies concerning with the behaviour of the marketed surplus and (2) Production response studies. The empirical studies can also be divided into (1) Work on overall supply and (2) work on individual commodity supply on the plan of the level of supply response analysis made. On the consideration of the methodology followed in the analysis the work can be segmented into (1) the studies using constructive method - method of deriving supply functions from data and information relating to production functions and individual behaviour and (2) Studies following statistical analysis of time-series data. On the chronological order, the studies may be classified as (1) The studies made before 1970’s and (2) The studies made after 1960’s. The above classifications are mutually exclusive and exhaustive in themselves. However, since it is supposed that the difference in the supply response result due to the interactions of various considerations on which the classification of studies is made separately, the simple classification as done above may not serve the purpose of finding out the possible reasons for the differing supply response results. Hence, manifold classification of the
studies has been made as shown in chart I, by taking into account the various aspects of study.

Since there is only a finger numbered number of studies on market supply response and our concern is to estimate production response to change in price, much importance is not attached to market supply response studies while making the review of previous studies. However, inorder to have a broader idea on supply response, review of market supply response studies have also been made separately without making any sub-classifications. The review of other studies have been organised on the line of manifold classification shown in chart 1.

2.1 MARKET SUPPLY RESPONSE STUDIES

The study of the behaviour of Marketed Surplus to change in price is relevant only to staple food crops, more particularly in the developing countries, as a large part of which in these countries is retained by the farm households for their self consumption. There is not much literature on this issue. The available literature shows that the issue has been either debated or studied with reference to under developed countries. There is no notable work of this type concerned with developed countries.

The Indian economists such as Khusro9,

FIGURE 1

CHART SHOWING CLASSIFICATION OF SUPPLY RESPONSE STUDIES.

SUPPLY RESPONSE STUDIES

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| MARKET SUPPLY RESPONSE STUDIES | PRODUCTION RESPONSE STUDIES |

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OVER ALL SUPPLY RESPONSE STUDIES

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| STUDIES USING CONSTRUCTIVE METHOD | TIME SERIES STUDIES |

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INDIVIDUAL COMMODITY SUPPLY RESPONSE STUDIES

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| STUDIES USING CONSTRUCTIVE METHOD | TIME SERIES STUDIES |

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STUDIES IN DEVELOPED COUNTRIES |

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STUDIES IN UNDER DEVELOPED COUNTRIES |

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Khatkhate\textsuperscript{10}, Mathur and Ezekiel\textsuperscript{11} and R.O.Olson\textsuperscript{12} have attempted to analyse the problem on a theoretical basis. From his theoretical study, with the help of offer curve, Khusro\textsuperscript{13} concludes that so long as farmers have normal forward sloping market supply curve, it is not necessary to assume that they will retain more only if they produce more; they will retain more even out of an constant produce if they get a lower price. This positive price responsiveness of marketed surplus is, however, based upon highly restrictive assumptions. Khusro maintained that negativity of consumption effect to be the cause of the positive price elasticity of marketed surplus.

However, R.O.Olson\textsuperscript{14} while discussing the impact of P.L. 480 food grain imports maintained that in subsistence agriculture, income effect on demand for consumption of a particular crop outweighs the price effect on production and

\begin{enumerate}
\item R.O. Olson (1960), Op.Cit.
\end{enumerate}
Consumption and therefore marketed surplus may vary inversely with market price.

Khatkhate also shared the view of R.O. Olson but his explanation for the negative response of Marketed Surplus is based on the fixed monetary obligations of subsistence farmers. He maintained that when prices go down, the subsistence farmers with their fixed or relatively fixed monetary obligations is forced to increase his production to meet his consumption as well as monetary obligations.

Mathur and Ezekiel have also examined the price elasticity of marketed surplus on the same assumption of fixed monetary obligation of the farmers. They maintained that if prices rise the sale of a smaller amount of food grains provides the necessary cash and vice versa. Thus prices and Marketable surplus tend to move in the opposite directions. However, the hypothesis of Khatkhate and Mathur & Ezekiel lack theoretical plausibility as they are based on unrealistic assumption of the food grain sale as the only source of farmers income at the subsistence level.

By following an approach of part a-priori and part empirical, V.M. Dandekar\(^{19}\) has concluded that the negative price elasticity of marketed surplus would be applicable only to the intermediate size farms which are either so small as to have no surplus to sell, nor so large as to show the positive response. He observed that only a small proportion of producers react inversely to prices. Dandekar's analysis is not, however, persuasive. His conclusion is based upon the unrealistic assumption of zero substitution effect or the substitution effect is completely overpowered by the income effect. Even at the empirical level, Dandekar's analysis is far from conclusive as it is based on the data of a single crop, Jowar. However, the empirical part of Dandekar's analysis is very significant since it has been made at the disaggregative level and brought out the differences in the marketed surplus response among different group of farmers.

Not much empirical research has been done about the market supply response. The study by Rajkrishna\(^ {20}\),

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T.N. Krishna\textsuperscript{21} and Dharam Narain\textsuperscript{22} for India, Khan and Chowdhury's\textsuperscript{23} study for West Pakistan, Mubyarto's\textsuperscript{24} for Indonesia and J.R. Behrman's\textsuperscript{25} for Thailand are some of the notable empirical studies in this regard. Rajkrishna's\textsuperscript{26} work is more interesting both analytically and empirically. His model of estimation of marketed surplus elasticity has acted as impetus to many empirical researches in this field. Due to non-availability of time-series data on marketed surplus over a significant period, Rajkrishna has adopted an indirect method by which he estimated the price elasticity of marketed surplus in terms of parameters (price elasticity of output, price elasticity of consumption and sale, output ratio) which can be approximated and estimated directly from

\begin{itemize}
  \item Dharam Narain, Distribution of the Marketed Surplus of Agricultural produce by size level of Holdings in India: 1950-51, Institute of Economic growth, Delhi, 1961.
  \item Mubyarto, The elasticity of the Marketable surplus of rice in Indonesia, Ph.D dissertation, Iowa state university, 1965.
\end{itemize}
data (Time Series) which is generally available. From his analysis he concluded that price elasticity of a single subsistence crop is positive and there is less likelihood for a negative price elasticity in the Subsistence agriculture.

But Nowshirvani\(^\text{27}\) has showed that the conclusion of Rajkrishna is too optimistic and the backward bending supply curve is possible with the correction in the assumptions made by Rajkrishna with regard to the substitution elasticity. He has doubted the empirical validity of the assumptions of Rajkrisna in the estimation of price elasticity of Marketed Surplus.

Using a model similar to Rajkrishna's\(^\text{28}\) J.R.Behrman\(^\text{29}\) has estimated price elasticity for the Marketed Surplus of Thai rice. However, he differed from Krishna in the measurement of on farm consumption and bringing in the time factor into the model. The result of Behrman's study indicates positive price elasticity of Marketed Surplus for Thai rice.

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Dharam Narain's study on Marketed Surplus response is an aggregate study based on the cross-section data of the households. The study revealed difference in the price responsiveness between two parts of an aggregate marketable surplus. The study pointed out that only one half of the aggregate Marketable surplus is a true commercial surplus and the other half is a distress surplus necessitated by the cash obligation of the farmer. The study come with the result that while the commercial surplus is showing positive relationship with the price, the distress surplus shows an inverse relation to price changes.

The result of pushpagadan's study is in conformity with the conclusion of Dharam Narain that the farmers with commercial surplus respond positively and with distress surplus respond negatively to price charges. However Pushpagadan's study indicated that the commercial surplused farmers with stock behaviour only respond positively to price changes. The study is made only with reference to the Marketed surplus of Paddy crop.

Following Dharam Narain, Khan and Chowdhury have studied Marketable surplus behaviour of West Pakistan

farmers with the help of family expenditure survey data. They have estimated marketable surplus functions for farmers with various specifications by classifying the farmers as Marketers and Non-marketers and farmers in irrigated and less irrigated districts and came to the conclusion that Marketed quantity is an increasing function of rent payment. This relationship is more pronounced in the case of Marketers and farmers in the less irrigated districts. There is no conclusive evidence for the influence of cash sources in the Marketable surplus. It should be noted that Khan and Chowdhury's model has not taken into account the price variable in estimating Marketed surplus function.

On the whole the survey of Market supply response points out that the Marketable surplus arising out of monetary obligation of the farmers are in general showing a negative relationship with the price changes and only true commercial surplus bears positive relationship with the price changes. Most of the empirical works on this subject have been made with the reference to single crop. The studies using time-series data have estimated price elasticity of Marketed Surplus only indirectly. There is no aggregate time-series study on this subject. Almost all studies in this field have been made before 1965. The above review is much useful for the present purpose in as much as it helped for a broader understanding of the farmers'
behaviour to changes in the price of agricultural commodities.

2.2 PRODUCTION RESPONSE STUDIES

It may be pointed out at the outset that the review may not be complete in itself when a large chunk of published and unpublished study made in the developed countries are left out of perview. Moreover, most of the studies made in the developing countries are having their root in the studies of the developed countries. The rapid development of theories on this subject can be traced only after the work of Marc Nerlove\(^{33}\) made in U.S.A. Now there are enormous literature on this subject ranging from individual commodity study to overall production study.

2.2.1 OVERALL PRODUCTION RESPONSE STUDIES

The literature on overall supply response prior to 1958 was summarised by Glenn L. Johnson\(^{34}\) in agricultural adjustment problems in a growing economy. In his summary, he felt that the work on overall supply response had been rather inadequate. Taking into consideration the latter growth in the number of supply response studies,


Sasikala Sawant viewed that relatively very little work has been done to analyse the response of aggregate supply to price changes and the question has remained almost neglected and therefore unsettled. The studies have estimated overall farm elasticities (1) with the help of derived supply functions from classical production functions, farm budgeting and linear programming production functions taken separately (i.e., by constructive method) as well as (2) by following positivistic measures of aggregate supply elasticities (Time series analysis).

2.2.1.1 OVERALL SUPPLY RESPONSE STUDIES IN DEVELOPED COUNTRIES USING CONSTRUCTIVE METHOD

This method of estimating overall agricultural supply response have been rarely followed. In a survey article on agricultural supply analysis, Nerlove and Bachman concluded that too few studies have been conducted in which supply functions have been derived from production functions of either neoclassical or programming variety and no meaningful attempts have been made to aggregate such


functions. The study by L.J. Wipf and D.L. Bawden relating to U.S. Agriculture is an attempt to examine the reliability of supply functions derived from production functions. The authors have derived firm level supply functions from production functions of selected agricultural commodities for various regions in U.S. and use it to predict firms output and to estimate supply elasticities. These elasticities are compared with the elasticities estimated directly by regression analysis and with actual output. Comparisons are also made for different lengths of run using same production function and among different types of production function for a given commodity. From the analysis, the authors came to the conclusion that output predictions obtained from the derived supply approach range from slight under estimates to extreme over estimates of actual output with the latter being most prevalent. Besides the derived supply elasticities were generally higher than those obtained by direct regression analysis. The study also reveals that elasticities and output predictions based on derived supply functions seem to be over sensitive to changes in the length of run. These unacceptable results led to the conclusion that derived supply equations are not empirically reliable.

Zvi Griliches\textsuperscript{38} has illustrated that the supply elasticities can also be estimated from the input demand elasticities. He measured aggregate supply elasticity by expressing supply functions as the weighted average of all the elasticities of demand for individual inputs with respect to the price of the product and taking factor shares as weights. From the estimates he came to the conclusion that the supply of agricultural products may not be as inelastic as has often been assumed. He further contends that while the short-run elasticity is low, the long-run elasticities may be quite high.

The review of the supply response studies using linear programming approach has been made by Randolph Barker et al.\textsuperscript{39}. The review indicated that even though there is a progress in solving the problems relating to the construction and aggregation of firm supply functions from individual farm data, many additional problems must be solved in creating a more dynamic firm model and in using the linear programming approach to get useable estimates of national and regional supply. Concrete applications of


linear programming technique to derive firm supply function in the early period have been made by Tompkin\textsuperscript{40}, and Mcpherson and Faris\textsuperscript{41}. They support the conclusion that farmers attempt some adjustment to prices.

After pointing out the number of problems connected with the estimation of aggregate supply response from the time-series data, Davey and Weightmen\textsuperscript{42} have adopted a normative approach in which they attempted to estimate aggregate supply from optimal programmes for a set of representative farms by using linear programming technique. The result show that the model gave a quite reasonable result. From the result, the authors maintained that this approach can be taken only as a complement to time-series analysis in the estimation of aggregate supply response.

While discussing the use of representative firms in inter-regional competition and production response models,

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Day \textsuperscript{43} maintained that it is a means of bringing in micro data to bear Macro problems and a means of reducing the effect of aggregation bias common to spatial equilibrium and recursive programming production response models.

In a recent paper, while tracing the role of representative farms in the regional adjustment studies, Sharples \textsuperscript{44} has discussed the various cases for and against using representative farm approach in the estimation of aggregate supply response. He came to the conclusion that RFA model may not play a major role in future research of intermediate and long-run aggregate supply response. However, he maintained that RFA can play an important role in the short-run aggregate supply response. Excepting the simple analysis made by S.C. Hsieh \textsuperscript{45} for Taiwan, there is no notable study in aggregate supply response using constructive method with reference to underdeveloped countries. The study by S.C. Hsieh come to the conclusion


that the agricultural production planning is less influenced by the usual economic factors. In general the review indicates the limited applicability and doubtful reliability of the constructive method approach in the estimation of overall supply elasticity.

2.2.1.2 OVERALL SUPPLY RESPONSE STUDIES USING TIME-SERIES DATA-STUDIES IN DEVELOPED COUNTRIES

In a second attempt to estimate aggregate supply function for U.S. Agriculture Zvi Griliches employed relatively simple and direct method of estimation. By adopting distributed lag model with the variable viz., index of relative prices, one year lagged output, Stalling's weather index and Time trend to represent technology, he came to the conclusion that the aggregate U.S. Agricultural supply is responsive to price changes and it is relatively more elastic in recent years. The relative instability of the distributed lag model in aggregate supply response study is made explicit by the result of his study.

Luther G. Tweeten and C. Leroy Quance have also estimated aggregate supply function for U.S. Agriculture by


following three positivistic approaches. The first approach is a direct least square estimate of the aggregate supply function. The other two are disaggregate approaches. One involves direct least square elasticity estimates of the separate yield and basic production unit components of crops and livestocks. The four elasticities so obtained are then aggregated to arrive at the total aggregate supply elasticity of farm production. The approach involves indirect computation of aggregate supply elasticity from production elasticities and demand elasticities for eight farm inputs with respect to the prices received by the farmers. The study revealed a low but decidedly positive supply response. The study also indicated higher aggregate supply response for increasing prices than decreasing prices. The study has not specified an independent variable to represent the level of technology rather it used productivity index which reflects changes in Management, technology and the influence of weather combined together.

In the recent decade, S.Pandey et al. have estimated aggregate supply response for Australia by using log linear regression model. The elasticity estimate found for Australia is consistent with the estimates found for U.S. by

Griliches\textsuperscript{49} and Luther G. Tweeten and C. Leroy Quance\textsuperscript{50}. However, the study for Australia showed an improvement in the aggregate supply elasticity over other two estimates. Like Griliches\textsuperscript{51}, the authors have used trend variable to represent technology but they have used dummy variable to represent the change in weather. As compared to the previous two studies, the study was made relatively in the recent past.

\section*{2.2.1.3 Overall Supply Response Study Using Time-Series Method - Studies in Under-Developed Countries}

There is only a limited number of studies on aggregate supply response relating to the agriculture of underdeveloped countries. Robert Herdt's\textsuperscript{52} study is the only notable earliest study in this direction made on Indian agriculture. The study has adopted a disaggregate approach to estimate aggregate supply elasticity. Separate supply elasticities have been calculated for irrigated and non-irrigated crops in terms of area and the yield of the crops for the periods 1907-1946 and 1951-1964. Own price elasticities and gross elasticities of different crops so

\textsuperscript{52} Robert W. Herdt, "A Disaggregate Approach to Aggregate Supply", \textit{American Journal of Agricultural Economics}, Vol. 52, No. 4, November 1970, PP. 512-520.
obtained are then aggregated to get aggregate elasticity of farm production using average value of production of different crops as weights. The analysis revealed positive aggregate supply elasticity in the range 0.1 to 0.2 during 1907-1946, the period of unchanging traditional agriculture. The result relating to the period 1951-1964, the period of changing technology, are however inconclusive. The failure to take into account the technological change in the model might have contributed for the poor result obtained for the above said period. The distributed lag model adopted in the study produced serious methodological problems in the estimation of aggregate supply elasticity. The price elasticities obtained in this study are relatively small as compared to the corresponding elasticities in the case of developed countries. However the study is considered most important as it brought out the fact that farmers in traditional agriculture do respond to prices.

Sasikala Sawant has attempted to estimate aggregate supply response for the predominantly paddy growing districts of India by approximating the supply response of rice to aggregate supply response. Using alternative specifications in the Nerlovian partial adjustment model, she has tried different models to overcome the methodological problems encountered in the measurement

of overall supply response in agriculture to change in price. In the model finally adopted, she has included supply shifters such as weather, irrigation and technology. The estimates of supply elasticity found for pre-war period (1920-42) are almost zero for a majority of district. Increased evidence of positive response for plan period (1950-1965) is indicative of future increased response of agricultural supply to change in the price. The elasticity estimates ranged in between 0.1 and 0.3 which is plausible result for U.D.C's when compared to the corresponding results for developed countries. The study revealed variation in the pattern of price response between the districts. The study also indicated that the average response even of an individual crop may under estimate the supply response if a technology variable is not properly specified in the model. However the model adopted by Sawant is of only relevance to an area endowed with single crop.

Recently Bapna54 has estimated supply elasticity of aggregate production and its components, area and yield in a Gujarat district for two sub-periods viz., (1) 1956-1965, termed as the period of traditional technology and (2) 1966-1977, known as period of modern technology. The study provides strong evidence that the aggregate supply elasticity of total agricultural production is positive.

The study also outlines that the supply elasticity of overall production in agriculture under modern technology is more than in traditional agriculture.

On the whole the review of time-series aggregate supply response studies reveals the serious methodological aggregation problems in the estimation of overall supply response. The review seems to uphold Glenn L. Johnson's conclusion that commodity supply response studies have been relatively more successful than supply response studies for the entire agricultural industry. The review also indicates that the best aggregative estimates are possible only when there is improved commodity estimates. In this context, estimation of commodity supply response seems to be more relevant.

2.2.2 Individual Commodity Supply Response Studies

2.2.2.1 Studies in the Developed Countries Using Constructive Methods

Notable earlier studies in this direction are that of Knutson and Cochrane's and Henderson's.


Knutson and Cochrane\textsuperscript{58} have attempted to derive synthetic supply function for flax at the firm level by using the optimal programme of the firms. Henderson,\textsuperscript{59} by developing a system of constraints in the linear programming model has attempted to predict crop acreages in a dynamic system. The studies revealed positive response of farmers to price changes.

By adopting recursive programming model, R.K.Sahi and W.J.Craddock\textsuperscript{60} have analysed the acreage response of major crops grown in prairie during the period 1958 to 1969. They have come to the conclusion that price is one among the influencing factor of crop acreage in prairie. the model adopted in the study has explained land utilization pattern with reasonable accuracy.

Recently Brain S.Fisher and Robyn G.Munro\textsuperscript{61} have estimated supply response models for a number of major agricultural products grown in Australia using survey data on growers intentions and price expectations. The results of

\begin{itemize}
  \item\textsuperscript{58} A.C. Knutson and W.W. Cocharane (1958), Op.Cit.
  \item\textsuperscript{59} J.M.Henderson (1959), Op.Cit.
\end{itemize}
their analysis showed no difference from the existing estimates of time-series analysis. However, the studies of this type using constructive method is not free from aggregation problems arising out of the inter-farm differences in th use of inputs and adoption of technology.

2.2.2.2 COMMODITY SUPPLY RESPONSE STUDIES IN UNDERDEVELOPED COUNTRIES USING CONSTRUCTIVE METHODS

Like in developed countries only a scattered number of study of this type is available with reference to underdeveloped countries. J.C.Flinn etal\textsuperscript{62} have estimated rice supply and input demand elasticities for farmers in laguna, Philippines. The analysis implies that Laguna rice farmers respond to price changes in an efficient manner. However this analysis seems to be not useful in the case of the estimation of long-run supply elasticities.

The study by S.A.Oni\textsuperscript{63} attempted to estimate the acreage response among the Western Nigerian Cocoa farmers by adopting producer's panel approach and time series analysis. The estimates obtained through three functional forms of the acreage response model-linear, power and exponential-reveal


that the current response of farmers may deviate substantially from that revealed by Time-series analysis. The cross-section study revealed some negative response at low producer price of cocoa. The study indicates the need to supplement time-series analysis by a cross-sectional analysis.

Using the normalised quadratic profit function approach, Ramesh Chand and Praduman Kumar\(^6\) have attempted to estimate supply function for major crops of Punjab in the green revolution period. Result of the study indicate that given the level of technology, there is limited scope for increasing output by tampering the price. The authors found superiority in the normalised quadratic profit function model over regression and production function model in the estimation of supply elasticities.

S.B. Tambad and B.V.S. Baliga\(^5\) have estimated price elasticity of paddy for Mandya district of Karnataka state from cross-section data for the year 1962-63 by adopting powered form Cobb-Douglas production function approach. The study revealed positive responsiveness of farmers to product prices and negative responsiveness to input prices.


However, the plausible supply response result obtained by Surjit S. Sidhu and Carlos A. Baanate\textsuperscript{66} for the wheat, produced in the Indian Punjab farms through the normalised restricted translog profit function, demonstrates the lack of support for the Cobb-Douglas form of profit function to derive supply elasticity.

Daya Singh and A. S. Kahlon\textsuperscript{67} have found superiority in the Recursive programming model over the regression model of Nerlovian type in accurately estimating the supply elasticities of nine major crops grown in Haryana. The authors contended that the results arrived through recursive programming model are more reliable than the results arrived through the Nerlovian type regression model as it incorporates the influence of farm technology empirically and recognises the interdependence of crop alternatives.

In Coimbatore district of Tamil Nadu, A. Kandaswamy\textsuperscript{68} has estimated normative supply functions with reference to


price of cotton, Groundnut and Sugarcane by adopting linear programming approach. The estimated elasticities have been compared with the estimates of positive analysis of time-series data. The comparison revealed that the price elasticity of normative supply are greater than that of time-series analysis. The difference is one of the gap between exante and ex post decisions. The risk in production against which the farmers have to discount is offered as the reason for the lesser ex post elasticity of Time series analysis.

Recently, K. Kalirajan and J. C. Flinn\(^6\) have studied the supply response of farmers producing modern variety of rice in Coimbatore district by adopting restricted profit function approach. The study provides positive evidence on the farmers' degree of responsiveness to price movements for paddy production. The study also indicated difference in the price responsiveness between farmers producing exotic modern variety and locally bred varieties.

On the whole the review indicates positive supply responsiveness of farmers to change in price. However, the studies are not free from methodological limitations specific to this type of approach. On the plan of

reliability and applicability of supply elasticity estimates, the time series analysis is having an edge over the constructive method approach.

2.2.2.3. COMMODITY SUPPLY RESPONSE STUDIES USING TIME SERIES DATA—STUDIES IN DEVELOPED COUNTRIES

The studies of time-series analysis may be in the form of graphic and Tabular analysis or in the form of econometric analysis varying from simple correlation analysis to modern regression analysis. Generally speaking, there is no study in developed countries using graphic and Tabular method. Most of the studies in these countries are made with the sophisticated regression models. In the order of importance, the first study to be given priority is that of Marc Nerlove's, since it formed the basis for many studies on this subject. However, as Marc Nerlove's study is an development in the light of mistakes committed by the previous studies, it becomes necessary to review the studies before Marc Nerlove. The More important of these studies are those of Bradford Smith, Louis Bean,

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Robert Walsh\textsuperscript{73} and R.L. Kohls and Don Paarlberg\textsuperscript{74}. All the studies show very little response of acreage to change in price. Nerlove\textsuperscript{75} maintained that inappropriate handling of price expectations and production adjustment possibilities by these studies was responsible for their low estimates. To remedy this, Marc Nerlove\textsuperscript{76} has used distributed lags in his attempt to estimate the elasticity of supply for corn, cotton and wheat in the U.S.A. He has used a three equation model. The first equation, $X^*_t = a_0 + P^*_t + U_t$ states that the desired area ($X^*_t$) is a function of expected price ($P^*_t$). The second equation, $P^*_t - P^*_{t-1} = \beta ( P_{t-1}^* - P^*_{t-1} )$ indicates that each year farmers revise the price they expect to prevail in the coming year in proportion to the error they made in predicting price this period. This equation was originally developed by Phillip Cagan\textsuperscript{77}. The third equation, $X_t - X_{t-1} = \gamma ( X^*_t - X^*_{t-1} )$

\begin{itemize}
\item \textsuperscript{74} R.L. Kohls and Don Paarlberg, \textit{Short-time Response of Agricultural Production to Price and Other Factors}. Purdue University Agricultural Expt. Station Bulletin 555, 1950.
\item \textsuperscript{75} Marc Nerlove, \textit{The Dynamics of Supply - Estimation of Farmers Response to Price}. The Johns Hopkins press, Baltimore, 1958.
\item \textsuperscript{76} Marc Nerlove (1956), Op.Cit.,
\end{itemize}
represents a development over the formulation of acreage response function suggested by the work of L.M.Koyck\textsuperscript{78}. This equation seems to be the original contribution of Marc Nerlove to the supply analysis which states that the actual planted area in each time period ($X_t$) is adjusted in proportion to the difference between the last year planted ($X_{t-1}$) and the current year desired area ($X^*_t$). By substituting second and third equation in equation one, Marc Nerlove has got the estimating equation, $X_t = \pi_0 + \pi_1 P_{t-1} + \pi_2 X_{t-1} + V_t$. This formulation appears to be every plausible as it allows for technological and institutional constraints prevalent in agriculture. However the model seems to be incapable of providing separate elasticities for increasing and decreasing prices by its assumption of constant co-efficient of price expectation. The study revealed higher supply elasticities with respect to price over the corresponding previous estimates.

Brian E.Hill\textsuperscript{79} found serious defects in the use of Nerlove's agricultural supply response model by its implication of constant technology which does not allow for changes in the long-run supply curve. He pointed out that

\textsuperscript{78} L.M.Koyck, \textit{Distributed Lags and Investment Analysis}, North-Holland publishing company, Amsterdam, 1954.

the technological change is an all pervasive supply shifter and hence the co-efficient of adjustment of lagged endogeneous variable is not an indicator of the rate of adjustment towards a long-run equilibrium as stated by Nerlove. As such the Nerlovian adjustment Co-efficient ignores the possibility of price influencing shifts in supply curves through the adoption of New Technology. By assuming co-efficient of price expectation and acreage adjustment co-efficient are equal to unity, Brian derived a regression model and estimated the supply elasticities for the cereals of England and Wales during 1956-70. The result reveals that the cereals are less responsive to change in price.

William G. Tomak has shown the sensitivity of empirical results to changing model specification by fitting an alternative distributed lag model to cotton data similar to that of Nerlove used. The analysis revealed that a change in the deflator of cotton price makes a difference in the price and trend co-efficient and a change in the method of allowing for shifts in supply changes the conclusion about lagged responses.

80. Brian E. Hill, Ibid.


By considering alternative disturbance specifications in conjunction with a variety of deterministic specifications, William E. Griffiths and Jock A. Anderson have attempted to estimate supply response in Southern New South Wales of Australia and found some empirical support for an additive disturbance and for the price rather than revenue as an appropriate specification in the supply function.

Gemmill developed symmetric and asymmetric Sugarcane acreage functions by adopting Nerlove's acreage adjustment equation with the specification of current Sugar commitment price and time trend for technology and applied them to eleven major cane producing countries of the world. The result of the study reveal common suitability of asymmetric function in the case of developed countries and symmetric model in the case of underdeveloped countries. The results show somewhat lower elasticity for symmetric function as compared to the elasticities revealed by asymmetric function.


Incorporating risk variable in the adaptative expectations geometric lag model by way of geometrically including quadratic lag terms, Richard E. Just has analysed the supply response for California field crops and came to the conclusion that the inclusion of risk factor yielded reasonable result. The study also indicated that the effect of stabilization policy of the Government might have seriously offset the acreage reducing effect of voluntary acreage restriction under the consideration of risk and other factors.

This conclusion has been further confirmed by the results of Robert Wilson et al. The authors contended that the inclusion of a risk element in a supply response model of a regulated crop at a regional level can provide the model with a better fit and more accurate estimation of price elasticities of supply and responses to government policies.

Lin opined that only a few supply response studies


have explicitly introduced risk element into the model. With three year moving standard deviation of the past actual returns per acre representing risk, Lin has estimated a polynomial lagged wheat acreage response model in Kansas for the year 1950-1975 and come out with better short-run price elasticity of acreage as compared to that of Nerlove's. However, the study has not given the conclusive evidence for the effect of risk on acreage response.

Peter B. Prosser has studied the importance of risk variable in the wheat acreage response by adopting linear and non-linear regression models and come to the conclusion that the revenue risk and technological variables are closely interrelated and from the aggregate data it is impossible to estimate the separate effects of these variables. While the revenue and risk variables are found non-significant, the tractor size representing technology is found to be significant explanator of wheat acreage due to their interrelationships.

Marcia Glenn and Ralph Lattimore have modified the Nerlovian model so as to take into account the effect of

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grain storage subsidies by way of including effective net returns and variance of wheat prices as independent variables in addition to the real price of Barley. The result of the study show that the model is theoretically quite plausible as it reduces multicolinearity problems arising between farm stocks and expected prices. The short-run elasticity estimates of this model is in line with other studies.

Bruce Traill by adding alternative definitions of risk variables in the conventional supply models of U.S. onion industry, came to the conclusion that the inclusion of risk variable improves the price co-efficient and predictive ability of the model but it does not enhance the explanatory power of the model. The study also revealed that none of the alternative risk variables is superior to each other but the definition of risk based on the deviation between actual and expected prices is theoretically more appealing than the approximation provided by the moving standard deviation definition.

John P. Brennen has also found no superiority in


the complex risk variables over simpler one and hence he suggested moving range over three or four years as an appropriate choice of risk for representing in the supply model.

Like the risk variable, the importance of making correct specification of technology has been stressed by James K. Whittaker et al. They maintained that the trend variable might not reflect the real situation if the technology does not advance linearly. To get rid of the problem of quantifying technology, they have suggested an alternative method in which the acreage response function is estimated by pooling time-series and cross-section data. The results of the study showed that the pooling is not a solution to the problem of representing uneven technological advance in the estimation of acreage response function.

Sensitivity of price elasticity results to changing estimation methods and models have been brought out by the studies of Wen S. Charan, Kym Anderson,


A.G.Antill\textsuperscript{95}, Jennings etal\textsuperscript{96} and K.D. Meilke and R.E.Kramar.\textsuperscript{97} All the studies have indicated response of acreage to change in price. Kym Anderson\textsuperscript{98} have shown empirically that the adaptive expectations geometric lag models are having an edge over the simpler adaptive expectation models and polynominal lag models in providing useful supply estimates of annual crops such as Barley.

A.G.Antill\textsuperscript{99} has applied three methods - least square method, the instrumental variable approach and approximate generalized least square-in the estimation of supply response and came to the conclusion that in the case of small samples OLS appears effective inspite of the considerations of bias and inconsistencies.

Jennings etal\textsuperscript{100} have studied the area response for G.B. main crop potatoes for the period 1955-74 by adopting a

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modified Nerlove's partial adjustment adaptive expectation model in which the methods of statistical time-series analysis are adopted rather than those of classical econometrics. The results of the study reveal that they have made theoretically plausible modifications in Nerlove's model. Their estimates of price co-efficient suggest that expected price changes are positively influenced by the last two year changes in particular rather than a geometric weighted sum of all past prices.

Bowlen¹⁰¹ has found simple regression as an appropriate tool in determining wheat acreage response in three homogeneous regions of Kansas.

By adopting seven regression formulations in the first degree, second degree and logarithmic form, Yair Mandlak et al.¹⁰² have studied the supply response of late spring potatoes in California for the period 1929-53. The results of their analysis indicate that late spring potatoes depend on prices and returns of alternative crop enterprises as well as late spring potato prices.


The variation in the price responsiveness even among the cereal crops has been brought out by the study of D.R. Colman\textsuperscript{103} in U.K. for the period 1955-67. By specifying returns per acre, cost per acre, time trend (for technology) and Martonne arridity index in the basic Nerlovian partial adjustment model, he came to the conclusion that while barley and oats acreage are showing strong response to change in price, wheat acreage shows little response to price changes.

Regional variation in the price response is indicated by the studies of B.J. Morzuch et al\textsuperscript{104} and O.Yul Kuwon et al.\textsuperscript{105} The studies have shown price responsiveness of crop acreages. The variation in the price responsiveness across periods has also been indicated by B.J. Morzuch et al's\textsuperscript{106} study. During non-quota years wheat acreage showed positive response to the relative price of wheat, whereas wheat allotment appeared important in quota period.

\begin{thebibliography}{9}
\end{thebibliography}
The result of Russell Lidman and D.Lee Bawden\textsuperscript{107} study seems to uphold the result of Morzuch et al. By constructing a model with the government intervention variables, Russel et al have come with the result that agriculture programme has exerted significant influence during the government intervention period. From this, the authors contended that simple lagged adjustment model of Nerlovian type is inappropriate for periods dominated by federal intervention.

B.J.Revell\textsuperscript{108} contended that a regional analysis of supply function would help to obtain an accurate estimate of national planted acreage since it results in increasing explanatory and predictive powers of the model.

On the whole the review of time-series commodity supply response studies of developed countries indicate that the price responsiveness of farmers varies over the period of time and between regions and crops. It also points out the sensitivity of price elasticities to changing model specifications and estimation methods. A specification appropriate at one time turns out to be inappropriate at the other time. Specification of risk, technological and


institutional factors led to reasonable estimates. A model suited for one country or region turns out to be unsuitable for the conditions of the other country or region. The contradicting results if any might have been the result of inappropriate specification or estimation procedures or ignoring some of the supply shifter variables. Hence, according to the circumstances there is a need to specify the variable and choose appropriate estimation method.

2.2.2.4. COMMODITY SUPPLY RESPONSE STUDIES USING TIME-SERIES DATA - STUDIES IN DEVELOPING COUNTRIES

It is generally held belief that farmers in underdeveloped countries respond little to economic stimulai such as price of the product. The earliest study in this direction made during the period 1900-28 indicated a significant relation between the price and the acreage of cotton, linseed and groundnut\(^{109}\). The study by Dharam Narain\(^ {110}\) during the period 1900-39 found that Indian farmers respond significantly to price. However, he pointed out striking difference between the response of cash crops

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and food crops. Mahabal's study in Bombay province for the period 1913-39 also showed variation in the price response between food and commercial crops. But, while the commercial crop responded positively to its price, the food crop showed no response to its price. The studies by G.B. Kulkarni for groundnuts of India and M. Srinivasan for commercial crops in Madras, made for the period 1922-53 and 1939-51 respectively support the result that commercial crops are price responsive. However, the study by G. Parthasarathy in Madras State for the period 1939 to 57 seems to uphold the general notion of non-price responsiveness of farmers in underdeveloped countries. He found that the non-price factors are responsible for the change in acreage under crops. Similar conclusion is brought out by the studies of A.S. Kahlon and S.S. Johl.


V.S. Vyas and Rakhral\textsuperscript{116} and S.B. Lal Gupta\textsuperscript{117} made for the period 1950-62. All of these studies revealed that price variability is lesser than yield variability and yield variability has a great say in influencing the decisions of the farmers with regard to acreage under different crops. The work of P.V. John\textsuperscript{118} indicated that though the price of rice and sugarcane influences their respective acreage, it is not the major determining factor of acreage.

The study of Shyamal Roy\textsuperscript{119} indicated significant positive influence of price on the acreage of Jute. However, he maintained that price is not the main factor behind the acreage shift. The study revealed variation in the price response result among the districts. The studies by

\begin{itemize}
  \item Shyamal Roy, "Supply Response to Changes in Price of Jute in West Bengal", \textit{Agricultural Situation in India}, Vol. 23, No. 6, September 1968, PP. 581-595.
\end{itemize}
M.V. George in Kerala and V.M. Jakkade and Mujumdar in West Bengal, Bihar and Assam indicated close correspondence between relative price and acreage of the crops. Study by Gupta and Majid has also come out with positive association between relative price and area under Sugarcane and paddy. However they maintained that the variation in the area is not altogether a function of relative price. All the above studies have used simple method of analysis i.e., graphic and Tabular analysis. However, they differed not only in respect of the techniques used for studying price response but also in respect of the specification of price variable. The studies considered here, though having the merit of simplicity, lack precision in their result.

To overcome this weakness in the estimation of supply response, some studies have used simple correlation and regression techniques. Some of the notable studies of this


type are that of Falcon\textsuperscript{123} G.D.Agarwal\textsuperscript{124} Kamaladevi and Rajagopalan\textsuperscript{125}, P.V.John\textsuperscript{126}, C.H.Shah\textsuperscript{127} subbarao\textsuperscript{128} and Bansil\textsuperscript{129} in the order of their period of study. In general the studies have come out with positive response of acreage to relative price. But, the studies by Agarwal, C.H.Shah and Bansil found little price impact upon the acreage. However, some of the studies have related relative area with lagged relative price, while others have made relationship between absolute area and lagged absolute price. The results of the above studies cannot be relied as they were obtained by

\begin{itemize}
  \item \textsuperscript{123} Walter P.Falcon, "Farmer Respose to Price in a Subsistence Economy : The Case of West Pakistan", \textit{American Economic Review}, Vol.56, May 1964, PP.580-591.
  \item \textsuperscript{124} C.D.Agarwal, "Prices and Production Trends in Agriculture", \textit{Indian Journal of Agricultural Economics}, Vol.9, No.1, March 1954, PP.36-43.
  \item \textsuperscript{129} P.C.Bansil, "Farmer Response to Jute and Paddy Prices", \textit{Indian Journal of Agricultural Economics}, Vol.26, No.4, October-December 1971, P.443.
\end{itemize}
relating price variable with the acreage or output in isolation of the other influencing factors.

In the light of the limitations of a simple correlation and regression models to analyse supply response in agriculture, most of the studies in this field have either used traditional multiple regression models or advanced dynamic multiple regression models with improved estimation procedures. The following are some of the notable studies using ordinary multiple regression models. Olayide\textsuperscript{130} studied the supply response of perennial and annual crops which played vital role in Nigeria's export trade. By adopting three price specifications in six functional forms—linear, second degree polynomial, power, exponential, square-root and semi-log function—he found that Nigerian crop producers rationally respond to better prices. The result also confirmed the response to depressing price policies of the Marketing Boards in Nigeria. The exponential functions showed a lead over others. The study used index of disease and trend in the model to represent risk and Technology variables respectively. Dean\textsuperscript{131} by employing price and non-price variables transformed to a percentage basis and first


difference basis, come to the conclusion that Malawi farmers are facing with upward sloping supply curve for their Tobacco produce. The study by Satyanarayana\textsuperscript{132} revealed variation in the price response to sugarcane acreage between the states. However, it comes with the general result that the area under sugarcane is influenced by the factors other than the price. In one study by M.S. Rao and Jaikrishna\textsuperscript{133} twelve different expectations models have been tried. The acreage under wheat is regressed against price index of wheat and weighted average price index of competing crops. The results of the study indicated difference in acreage response result depending upon the estimate of expected price used. Kahlon et al\textsuperscript{134} while studying the structure of farm price in Punjab found that wheat acreage respond positively and significantly to changes in the prices of wheat and gram. This finding is supported by the result of Lalita Sud and A.S. Kahlon\textsuperscript{135}. However, in their study the

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gram price turned out to be insignificant factor in influencing the wheat acreage. But the competing crop, wheat, price appeared significant in the gram equation. The result of the study indicated difference in the price response among crops and between states. By running two multiple regression equation in linear and exponential form with the independent variables viz., harvest price, pre-sowing period rainfall and yield per hectare, R.P.Singh et al.\textsuperscript{136} have come to the general conclusion that technology and price are the important factors influencing the acreage. The study showed inter-crop difference in the price response. Boon-raung et al.\textsuperscript{137}, have also come with price responsiveness of farmers in allocating area to Groundnut. Their study showed inter-state difference in the price responsiveness of farmers. It should be noted that the studies by R.P.Singh et al and Boon-raung et al have not used risk variable in their estimating equation. By running two multiple regression with two different price specifications, M.Subramanyam\textsuperscript{138} found that price of groundnut kernal exerted heavy influence on the groundnut acreage.


Using sixteen different linear regression models consisting of four acreage, six yield and six output models, M.M. Batra\textsuperscript{139} estimated the supply response of bajra crop for traditional and modern technology periods and come to the conclusion that there is significant difference in the supply response of subsistence crop before and after the introduction of HYV programme. While absolute price exerted significant influence during traditional technology period, relative profitability took its place in the modern technology period. Cost of production as explanatory variable has also declined in importance after the introduction of new technology. The study has not considered the risk factor in the analysis.

After the work of Marc Nerlove, most of the studies in underdeveloped countries made use of Nerlovian adjustment lag model by adding some of the shifter variables such as risk technology and institutional factors. Employing yield, risk and population variables in the basic Nerlovian model, Behrman\textsuperscript{140} analysed the responsiveness of four major crops—rice, cassava, corn and Kenaf—grown in Thailand during

\begin{itemize}
\item \textsuperscript{139} Madan Mohan Batra, \textit{Agricultural Production, Prices and Technology}, Allied publishers pvt. Limited, New Delhi, 1978.
\end{itemize}
the period 1937-63. The results of the study strongly support the hypothesis that farmers in underdeveloped countries respond significantly and substantially to economic incentives.

Rajkrishna\(^\text{141}\) made a pioneering attempt to apply Nerlovian econometric model to the analysis and study of farm supply response in India. By including relevant supply shifter variables such as relative yield of the crop, total irrigated area and rainfall in the basic Nerlovian Model, he found that farmers positively respond to price and the responsiveness varies as between different crops and regions.

Inspired by the work of Rajkrishna many researchers have attempted to estimate supply function in various parts of India by following Nerlovian model of Rajkrishna type. However, the studies differed among themselves not only in the specification of price variable but also in the specification and employment of the number of shifter variables in the basic Nerlovian adjustment lag model. The studies by Mahender Reddy\(^\text{142}\),


Chandresh Kumar, K.P.C. Rao et al., P.C. Verma, and R.D. Singh and P.R. Rao are some of the studies which support the result of Rajkrishna. They found that the farmers' response to relative price changes in allocating area under different crops. While Mahender Reddy used trend variable in addition to the variable specified by Rajkrishna, Verma has used relative price risk as additional variable. R.D. Singh and P.R. Rao have used both time trend and risk as additional variables in their estimating equation. The specification of risk variable is not same in all the studies.

The study by Jawahar Kaul for five food crops and two cash crops grown in Punjab state using Nerlovian type


acreage adjustment model suggest that commercial crops are more responsive to price than food crops. The author found that the inclusion of rainfall for three months prior to sowing season instead of total rainfall improves the result. The study revealed inter-distinct and inter-crop variation in the price response.

Using simple as well as Nerlovian non-iterative lagged model, S.N.Kaul\textsuperscript{149} found significant response of cotton producers to price changes both in the short and long run. The result indicated that simple linear model furnishes elasticities which are higher than the distributed lag models. Variables used in the model also affects the magnitude of price elasticities. The study indicated zonal and time difference in the price response.

More or less similar result is brought out by the study of C.C. Maji et al\textsuperscript{150}. They found difference in the price responsiveness of farmers between crops as also between dynamic and static models used in their estimation. They showed that the inclusion of risk variable in the log-linear Nerlovian adjustment model improves the co-efficient


of price variable. They have used moving standard deviation of prices both absolute and relative, together and alternatively as a variable to measure the risk.

By employing alternatively standard deviation and co-efficient of variation of Relative profitability along with Relative profitability variable in the Nerlovian type model, J.L.Kaul and D.S.Sidhu\textsuperscript{151} showed that the co-efficient of variation in place of standard deviation improves the price elasticity estimates and explanation power of the model. The study revealed that the long-run elasticities are higher than the short-run elasticities. It also indicated difference in the price elasticities between the crops.

Dileep M.Wagle\textsuperscript{152} examined the effect of tariff protection to the Indian Sugar Industry in the 1930's on the acreage under sugarcane by using distributed lag model. The significant price response of sugarcane acreage in the post tariff period as against insignificant price response in the pre-tariff period suggested causal relationship between


Dayantha Jha\textsuperscript{153} has studied the impact of relative price and some non-price variables on the sugarcane acreage by using Nerlovian model and come to the conclusion that farmers react to the relative prices both in the short and long-run but they react to the absolute prices of both cane and gur only during the short-period. They have used time trend to represent technology.

In one study, using log linear Nerlovain function R.L.Rathod\textsuperscript{154} found that farmers respond both to gur and wheat prices in allocating acreage to Sugarcane crop. However, the response to price and non-price variables varies between various groups and districts. the relative yield and cane acreage infested with pests and diseases are also the factors entering into the decision of the farmers.

In another study, under the same frame work, Rathod\textsuperscript{155} has tested the hypothesis that Sugarcane supply

\begin{thebibliography}{99}
\bibitem{154} K.L. Rathod, "Response of Sugarcane Producers to Prices: A Case Study of Western Uttar Pradesh", \textit{Agricultural Situation in India}, Vol.28, No.6, Sep.1973, PP.393-395.
\end{thebibliography}
response is more closely and significantly related to the difference between gur and minimum cane price than to gur price alone. But the result showed no much difference in the price response between two price specifications.

Specifying price risk and yield risk in the log linear Nerlovian model along with the same set of variables used by Rathod\textsuperscript{156} Lal and Singh\textsuperscript{157} found the positive response of sugarcane acreage to changes in relative prices and negative response to the risk of price fluctuations. This study also indicated regional disparity in the farmers' response to price and non-price factors.

Using gross relative profitability instead of price in the log Nerlovian model along with the co-efficient of variation of price, rainfall during pre-sowing months, area infested with disease and pests lagged one year and time trend variables, Singh and Bhatnagar\textsuperscript{158} found that the gross relative profitability is the most important influencing factor of sugarcane acreage.

\begin{thebibliography}{99}
\bibitem{156} K.L. Rathod, Ibid.
\end{thebibliography}
By incorporating a variable for directional differences in price variable in the Nerlovian Model, V.N. Misra\(^\text{159}\) found difference in the price response result for increasing and decreasing prices. The study also indicated the inter-regional and inter-crop variation in the price responsiveness of the farmers. Sensitivity of price response result to changing model specification is also evident from this study.

The studies by Sharma et al.\(^\text{160}\) Narayana and Parikh\(^\text{161}\), Pal and Mazumder\(^\text{162}\) have come out with positive but low response of acreage to price changes. The studies have used Nerlovian model in logarithmic form. Excepting Narayan et al study, the other two studies have employed risk variable in their estimating equation. While Sharma et al employed both price and yield risk, Pal and Mazumder adopted price risk only.

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\text{162. Aswini Pal and Nihar Ranjan Mazumder, "Impact of Prices on Area Fluctuations of Tobacco in West Bengal", }\textit{Agricultural Situations in India}, \text{ Vol.40, No.3, June 1983, PP.167-170.}\\
\text{--------------------------------------}\)
The low price responsiveness of Indian farmers is further confirmed by the studies of NCAER\(^{163}\) and Lahiri and Roy\(^{164}\). However the two studies differ in the model employed by them. While NCAER's study adopted Rajkrishna type Nerlovian adjustment model, Lahiri and Roy adopted log Nerlovian model formulated in relative terms.

Using Nerlovian type model, Shyamal Roy\(^{165}\) found that farmers are highly price responsive to expected normal price in allocating acreage to jute crop. Adopting Rajkrishna type model with trend as additional variable, Singh and Kumar\(^{166}\) also came to the conclusion that farmers are responsive to price variability. Without shifter variables in the Nerlovian model, Ramesh also arrived at the same conclusion. He has used whole sale price Index of the crop deflated by the whole sale price Index of all other commodities.


The studies by Sahay\textsuperscript{167} and Gajja et al\textsuperscript{168} for groundnut have come with the same result that price is the decisive factor in the area allocation for groundnut and the degree of responsiveness of groundnut area to change in price varies between zones/districts. The most important result of Sahay is that the best price expectation for acreage response of groundnut in different zones was not the same. However, Jhala\textsuperscript{169} has found out that price is not the decisive factor of groundnut acreage. The study has employed log form of Nerlovian adjustment lag model. It also showed disparity in the acreage response between regions and between states.

R.D. Singh\textsuperscript{170} have made two studies along with others.

\begin{enumerate}
\item B.L. Gajja, Jagadeesh C. Kalla and D.L. Vyas, "Supply Response of Groundnut in Rajasthan", \textit{Agricultural Situations in India}, Vol. 38, No. 6, September 1983, PP. 403-406.
\end{enumerate}
to analyse the regional pattern in supply response. In both the studies they have adopted Nerlovian model framed in logarithmic term with various price specifications and relevant non-price variables. They have come to the conclusion that cultivators are price responsive and they have showed consistent geographic pattern in their price response. In both studies time trend has been used to represent technological factor.

Jaikrishna and M.S.Rao 171 have tried Nine different price expectation models and six different Response equations in the estimation of acreage response co-efficients for wheat in U.P. The results of the study indicate that acreage under wheat has been fairly elastic to changes in relative price of wheat and Substitute crops during the period of study. The study found superiority in the Nerlovian type models and model based on three year average of pre-sowing prices over the traditional model and model based on other specifications respectively.

The work of D.S.Tyagi 172 is a thought-provoking contribution in the field of supply response analysis. The study attempted to analyse the possibilities of building up


models of farmers' expectancy behaviour by analysing the nature and basis of future price expectations. Using expected prices so generated, and realised prices of some previous period, he further attempted to analyse the supply response of the farmers and came to the conclusion that farmers in Underdeveloped countries respond quickly, normally and efficiently to relative price changes.

Explicitly introducing technology, input cost and risk factor in the Nerlovian adjustment lag model, Gour found that the price and technology which appeared insignificant during traditional technology period appeared significant during modern technology period. The risk factor which appeared significant in the traditional technology period declined in importance in the modern technology period. The author has considered three types of risk viz., price risk, yield risk and subsistence risk while estimating the supply elasticity. Unlike other studies this study has used technology index rather than time trend or yield of the crop to represent technology.

By employing alternatively price and gross return and price risk and return risk in the Nerlovian model along with weather variables, L.N. Bhagat\textsuperscript{174} found that relative gross return rather than relative price in explaining acreage variation. Sensitivity of result to changing model specification and variation in the behavioural pattern of farmers between regions and between periods are the important indications of this study. The study has not considered technology factor in the analysis.

By relating current yield as a function of past yield, change in acreage, change in non-land inputs and change in rainfall and employing it in the standard Nerlovian model, Askari and Cummings\textsuperscript{175} found that anticipated yield seems logically important in planting decisions of farmers in the Indian states. The study has used trend variable but ignored risk variable in the analysis.


S.R. Subramaniam et al.\textsuperscript{176} and Gautam et al.\textsuperscript{177} have found the importance of weather factors viz., irrigated area and rainfall respectively in influencing the crop acreage. Both the studies have ignored the technology and risk variables while making supply response analysis.

A detailed study of the agriculture of Madras state has been presented by V. Rajagopalan\textsuperscript{178}. By dividing the State into three regions and adopting three variants of basic Nerlovian Model with the variables viz., relative crop price, lagged absolute crop price, lagged substitute crop prices, one period and two periods lagged acreage and a trend variable, he came with the result that price is the important determinant of acreage. However, the study showed variation in the acreage response between regions and crops. He attributed the regional difference in the result to the degree of industrialisation, the source of irrigation water and the regions' dependence on rainfall and to some extent, to government procurement policies.


Another multi-crop study of Madras has been conducted by M.C. Madhavan, who has considered the supply of four food crops - rice, sorgham, ragi and cumbu and four cash crops - cotton, groundnut, gingili and sugarcane, by using Nerlovian model expressed in log form with crop acreage, as a function of lagged crop price, lagged yield and the acreage of the crop and its competitor, and rainfall index compiled for the sowing period. The study has revealed that commercial crops are more responsive to the relative prices than the food crops. Yield is equally important factor affecting cereal acreage decision of the farmers.

Cummings has attempted to detect intersectional differences in price response by analysing the supply response of important crops grown in India and Pakistan in the post world war II period. The results of the study revealed difference in the response pattern of farmers to changes in the price and non-price variables between states and crops. The study has not dealt with the risk factor involved in the agricultural production.


Recently George and Mukherjee have estimated acreage function by following Nerlovian lagged expectation models with the variables, yield, price, wage rate and fertilizer price all lagged one year and come to the conclusion that the price and the wage rate are the influencing factors of paddy area. The importance of this study lies in the employment of a measure of cost of production in the estimation of acreage response.

TO SUM UP THE REVIEW INDICATES

1. The Superiority of Nerlovian Model over traditional models in the estimation of both short-run and long-run supply elasticities.

2. Specification of appropriate price variable improves the price response result.

3. Price expectancy behaviour of the farmers differ from region to region. Appropriate price expectation model is not the same for all regions.

4. Specification of shifter variables such as risk, technology and weather improves the price response result.

5. Price response result varies according to model specifications and estimation methods.

6. There is variation in the price response result between regions/districts and between crops within a region/district.

No doubt, these points are very much useful for making systematic appraisal of the problem, making appropriate model specifications and adopting correct estimation procedure for the analysis. However, there are certain gaps in the existing studies.

(1) There is no notable study which attempts to analyse the supply response in relatively small geographical areas within a district.

(2) Most of the studies have either ignored the risk variable nor taken into account partially. Most of the studies using risk variable have considered price risk ignoring yield risk and the risk of cost of cultivation. There is no notable study which have explicitly employed the risk of cost of cultivation in the analysis. There is no notable study using risk variable in Tamil Nadu.

(3) Most of the studies which attempted to quantify technology have either used yield or time trend to represent technology. But, the variation in yield cannot be solely attributed to the technology factor, it may also be due to weather condition. Hence yield may not act as an appropriate specification of technology. Similarly time trend may not represent technology if technology does not proceed linearly.
Almost all studies have ignored the improvements in the institutional condition while estimating the supply elasticities. In the past one and a half decade, there is a spectacular improvement in the Bank advances to agriculture. Similarly, there is considerable improvement in the marketing arrangements. Hence, they need to be taken into account.

The studies which used the relative profitability as a variable have ignored the duration of the crop while calculating the relative profitability.

Excepting one or two studies most of the studies were confined to the period before 1975.

There is limited number of studies using both time series and cross-section analysis to estimate the supply response.

Multi-crop district level studies are limited in number.

There is scanty number of time-series studies using cost of cultivation as an explanatory variable of acreage under a particular crop.

So far no attempt has been made to estimate supply response in Periyar district, the agriculturally progressive district of Tamil Nadu.