A REVIEW OF THE LITERATURE

Agricultural production (supply) analysis is a well-researched area in agricultural economics. In empirical research the question as to how farmers respond to price incentives has been widely investigated. A review of the research in this field seems desirable, before commencing discussion on methodological details and findings of the present work. The present chapter is devoted to such a review. First a review of the general debate over supply response in underdeveloped agriculture is attempted which is followed by a review of empirical research in this field. Thereafter, the work done on farmers' expectation of future prices is examined. Lastly, it is shown that in supply response studies, findings of expectation behaviour studies have not been integrated.

It may be pointed out at the outset that, in a way, the coverage of this review is not full as some of the published and a large part of unpublished studies conducted in other countries is left out of its purview. This is so mainly because in the selection of the studies for review, preference was given to studies pertaining to Indian agriculture. However, an attempt is made to cover studies using all the different types of methodologies so as to make the review complete in respect of methodological details. The distinguishing feature
of this review from some earlier reviews\textsuperscript{1} of the work on supply response analysis is its accent on examining the methodological details rather than on compilation of findings of such studies.

II

A Priori Hypotheses About Supply Response:

In economic literature the question as to what is the nature of supply response in underdeveloped agriculture has been debated at length. The economists have come out with various a priori hypotheses about the supply response. Behraman suggests categorization of these hypotheses into three categories. These three categories are that (i) farmers in underdeveloped agriculture respond quickly, normally and efficiently to relative price changes, (ii) marketed production of subsistence farmers is inversely related to price (iii) institutional constraints are so limiting that any price response is insignificant\textsuperscript{2}. However, these categories are not mutually exclusive\textsuperscript{3} and, hence, the hypothesis of one category may not necessarily be in conflict with the hypothesis of the other and such a division is, therefore, likely to create confusion. If the distinction between total production and marketed surpluses is taken into consideration while examining various a priori hypotheses, a better way would be to have separate categories of hypotheses.

\textsuperscript{1} See, for example Marc Nerlove (I-65), Behraman (II-2), Tyagi (I-94).

\textsuperscript{2} See Behraman (II-2), pp. 3.

\textsuperscript{3} Behraman (II-2) himself writes "The major hypotheses... as stated in the earlier section are not mutually exclusive".
for the two; i.e., for total production and for marketed surplus. Two categories about the responsiveness of the total production then could be (i) Hypotheses that farmers respond positively and significantly to price and other economic incentives and (ii) Hypothesis of zero or negative price elasticity of supply. Similarly, the hypotheses about marketed surplus can be classified into two similar categories. These categories for each of the two magnitudes (total production and marketed surplus) are mutually exclusive.

About the responsiveness of total production to price and other economic incentives, major proponents of the first hypotheses that the farmers respond positively and effectively are Dantwala, Schultz, Falcon, and Raj Krishna. According to Schultz, the doctrine that farmers in poor countries either are indifferent or respond perversely to changes in prices is patently false and harmful.

Dantwala and Falcon emphasise that the composition of output respond to relative price changes. Bauer and Yamey cite as evidence the response of Nigerian cocoa and palm oil producers to increased price differentials for various grades of products, and Raj Krishna gives evidence of positive response of Punjab

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4 Dantwala (I-12)  
5 Falcon (I-19)  
6 Schultz (II-30), pp.49  
7 Bauer and Yamey (I-4)  
8 Raj Krishna (I-41)
producers to price incentives. Proponents of the hypotheses, that price elasticity of supply response in underdeveloped agriculture is zero or negative, are R.O. Olson, Khatkhate and Kusum Nair. Olson while discussing impact of P.L.480 imports maintains

... on the contrary there is convincing evidence that there is a negative supply response by way of income effect.

While Khatkhate argues that subsistence farmers may have fixed or relatively fixed monetary obligations and therefore maximise production and when prices go down he is forced to increase his production to meet his consumption as well as monetary obligations. Kusum Nair's findings are similar, though, largely based on personal impressions.

Amongst those who hypothesise that marketed surplus of subsistence farmers is inversely related to price, there are two groups. The argument of one group is based on the thesis of fixed monetary obligation of subsistence farmers, while other group feels that in subsistence agriculture income effect on demand for consumption of a particular crop outweighs the price effects on production and consumption and marketed surplus, may, therefore, vary inversely with market price.

9 R.O. Olson (I-70) also see, J.S. Mann (I-53).
10 Khatkhate (I-37).
11 Kusum Nair (II-23).
Mathur, Ezekiel and Khatkhate belong to the first group while Krishnan and Olson belong to the second. Those who derive their hypothesis of inverse relationship through the thesis of 'fixed monetary obligation' argue that as monetary obligations of most of the subsistence farmers are fixed any increase in price will bring a fall in marketed surplus because farmers in that case will be able to fulfill their monetary obligations by selling smaller quantities. According to Mathur and Ezekiel,

An increase in the prices of agricultural products makes it possible for the cultivator to satisfy his monetary requirement by selling a smaller quantity of foodgrains than before. The amount of foodgrains coming into the market thus tends to be reduced producing in its turn an upward pressure on prices.

Krishnan and Olson do not concern themselves with a fixed demand for monetary income; they merely argue that an increase in the price of subsistence crop may increase the producer's real income sufficiently so that the income effect on his demand for consumption of this crop outweighs the price effects on production and consumption. The marketed surplus may, therefore, vary inversely with the market price. Raj Krishna, on the contrary maintains

No one can asserts that the elasticity of market supply must be negative or positive in most cases. Both logically and empirically it can be positive in some and negative in other regions; and even in the same region it can be positive for aggregate market supply and negative for particular sub-classes of farmers.

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12 Mathur P.N. and Ezekiel (I-55) and Khatkhate (I-37) also see, V.N. Bandekar (I-10)
13 Mathur and Ezekiel (I-55), pp.399.
14 T.N. Krishnan (I-47), Olson (I-70).
In the literature on the subject, the above stated hypotheses relating to two different things have generally been mixed together and the hypotheses pertaining to marketed surplus have mostly been treated as if they pertain also to total production i.e. marketed surplus and total production have been assumed to respond in the same way. Behrman rightly suggests that debate over supply responsiveness of underdeveloped agriculture has been confused and intensified by the failure to make explicit distinction between (a) total production and marketed surplus (b) total agriculture production and production of any single crop, and lastly, (c) the relevant time periods. Produced quantities and marketed quantities need not respond identically to price and various other economic incentives. One may get positive response for output and negative for market supply. The situation can exist if an increase in the relative price of a subsistence crop causes a greater increase in consumption than in output. Similarly total agricultural production and production of a single crop need not necessarily behave in the same way, as relative price changes may vary the composition of crop mix to a sizable extent without making any significant change in the total value of agriculture production.

III

**Empirical Studies of Supply Responsiveness in Underdeveloped Agriculture:**

Two main points should be made explicit before starting the review of the previous empirical research work on supply

16 Behrman (II-2).
responsiveness. Both these points relate to the peculiar characteristics of agricultural production. The most striking characteristic of agricultural production is that farmers have very little control over the output and, hence, the planned output and realized output are rarely the same in any particular production period. It is this discrepancy between planned and realized output and non-availability of any kind of data about planned output except the acreage sown under a particular crop that led previous researchers to approximate planned output, to which the supply function actually refers, by acreage (planted or harvested). It is true that this approximation is far from being ideal\(^\text{17}\). However, most of the available data do not permit an analysis of the allocation of factors of production, except land, among different crops. Invariably, all previous researchers have taken acreage as a proxy for planned output. In the present study also the acreage sown is taken as proxy for planned output.

The second problem arises due to the time lag between use of inputs and availability of the output. In the production of almost all farm commodities, inputs must be committed to a greater or lesser degree some time before output is realized and hence the prices which farmers expect to receive for their

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\(^{17}\) Marc Nerlove points out "If the production of all other crops and all inputs were committed at the beginning of every production period, then, given the production functions, the planned output of any crop could be directly computed from the inputs committed to its production". See Marc Nerlove (II-26), pp. 66.
output and the prices which they actually have to pay for the inputs are of crucial interest rather than the past observed prices of output. Consequently, a large majority of the previous workers had to postulate some sort of functional relationship between past observed prices and future expected prices as no data on expected prices were available. These postulates have been made explicit by some workers while others have taken it for granted that the actually observed prices used by them were also the expected prices 18.

For an empirical measurement of supply responsiveness two general approaches are followed, namely, (i) constructive methods, which involve the derivation of supply functions from data and information relating to production functions and individual behaviour and (ii) Statistical analysis of time series data. Only a few attempts have been made to make use of the first method for deriving supply functions. It will, therefore, be convenient to start the review with the studies using constructive methods 19.

(A) Studies Using Constructive Methods:

On supply responsiveness in Indian agriculture no study so far has attempted to make use of constructive method. Concrete

18 For example Jai Krishna and M.S. Rao (I-40), Jakhade V.M. and Majumdar (I-31) make their postulates explicit while Kamla Devi (I-14), George M.V. (I-22) etc. do not mention any thing about the underlying postulates.

19 The only study which attempts to find aggregate supply responsiveness of Indian agriculture is that of Herdt. Since this is the only study of its type it will be convenient to discuss it along with other studies, which use the same basic tool which Herdt uses in his study but which deal with acreage allocation only.
applications of this technique to derive farm supply functions have been made only by Tompkin\textsuperscript{20} and McPherson\textsuperscript{21}.

Tompkin's study relates to 35 typical 160 acres Ohio farms, from which data was collected during 1956-57 and 1957-58. The method adopted has been to find out optimum adjustments (with the help of linear programming technique) which should have been made for optimizing the returns under given farm conditions, due to changes in the price actually received by farmers and also changes in the expected prices. The main conclusions of the study are: (i) Farmers attempt some adjustment to prices. Apparently they prefer to wait until it becomes obvious that a product price is up or down for longer than a year period. (ii) As a group they seem to make more adjustment to price changes which have already taken place rather than to prices expected by them. The other study by McPherson and J.F. Beories also uses the same methodology and supports the conclusions of Tompkin.

(B) \textbf{Statistical Analysis of Time Series:}

The studies using the method of statistical analysis of time series can be further divided into three groups on the basis of the tool or the technique used for establishing or for measuring farmers' response to prices.

\textsuperscript{20} Robert J. Tompkin (I-92)
\textsuperscript{21} McPherson (I-56)
Group I: Studies Using Graphic and Tabular Analysis:

In the studies falling in this group price-acreage relationship is studied by examining the correspondence in price changes and acreage changes either by tables or by graphs. To study producers' response to prices the correspondence in the changes in jute and rice price parity and acres under these crops is examined in one study\textsuperscript{22}. While in another study\textsuperscript{23} it is studied through the correspondence between (i) changes in the prices of individual crops and areas under these (ii) relative price changes and relative area shifted. Dharm Narain\textsuperscript{24} makes use of graphs in which two or more time series are brought together often one superimposed over the other on the same graph for gauging the correspondence in acreage shifts and price changes. The study by Kamla Devi\textsuperscript{25} follows a method in which the ranks of changes in prices and acres of different crops during two periods are examined. This study was confined to one state (Madras) only while the study by Jakhade and Majumdar covers two States (West Bengal, Assam) and the study of Dharm Narain pertains to all the States in the Indian Union. One more study falling in this group is a study of changes in cropping pattern due to changes in prices in Kerala by George\textsuperscript{26}. The changes in the crop pattern in the years 1952-53 to 1961-62

\begin{itemize}
  \item \textsuperscript{22} Jakhade and Majumdar (I-31).
  \item \textsuperscript{23} Gupta and Majid (II-10).
  \item \textsuperscript{24} Dharm Narain (II-24).
  \item \textsuperscript{25} Kamla Devi (I-14).
  \item \textsuperscript{26} George M.V. (I-23).
\end{itemize}
are compared with changes in the relative prices of six different crops. All these studies make use of the State level data of acreage under different crops. The study by Gupta and Majid is based on data relating to only one district and the crops covered by the study are sugarcane and paddy.

The studies in this group not only differ in respect of the techniques used for examining price response of the farmer but they also differ significantly in respect of the price variables considered.

In the study by Gupta and Majid farm harvest price of paddy and guaranteed minimum price of sugarcane, lagged one year, are considered as the prices relevant to farmers' decision on acreage allocation. Jakhade and Majumdar consider pre-sowing price (average of 4 pre-sowing months) as the relevant price for farmers' decision. They argue that because in the lean period farmers have to purchase rice for consumption out of the sale proceeds of jute, price of rice may be considered to determine the opportunity cost of using land for jute production. Dharm Narain in his study uses, due to the non-availability of any other price series, price quotations drawn from principal marketing centres of the country, deflated through a general price index. In her study Kaml Devi also makes use of monthly price quotations but she uses average of 5 years. It is interesting to note that the five studies of
this group consider four different price variables as relevant to the farmer for his acreage allocation decisions.

**Group II: Studies Using Regression or Correlation Coefficient:**

The studies falling in this group have used either the simple regression between price and acreage or the correlation coefficient between the actual acreage shift and the acreage shift which should have taken place to maximise profits. One study in this group uses a simple regression of the form

\[ R_t = a + b \cdot x_{t-1} \]

for calculating price elasticities\(^{27}\), while in another study, by John, an exponential function of the form \[ y = a \cdot x^b \] is used\(^{28}\). In the study by Robert M. Stern which covered Bengal, Orissa and Bihar the relative acreage of jute (relative to area under paddy) is regressed against the price parity of jute and rice lagged one year\(^{29}\). The period covered in some cases is as long as fifty to sixty years. In the study by Subbarao for Andhra Pradesh relative acreage under sugarcane is regressed against its relative prices\(^{30}\).

In the study by John three cases have been considered viz., (i) changes in area and output of a commodity in response to change in its price (ii) changes in area and output of a commodity in response to changes in relative prices, and, (iii)

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27 S.M. Hussain (I-30)
28 P.V. John (II-15)
29 Robert M. Stern (I-85), and also see, J.A. Schmittker (I-78)
30 Subbarao (I-87)
changes in area and output in response to changes in the prices of substitute crops. The prices considered were the farm harvest prices lagged one year. In the study by Hussain price elasticity of acreage under jute and rice in East Pakistan has been examined. Three different relative prices (i) the Aman price (i.e. harvest price of paddy during winter i.e., December to February), (ii) an average of Aman and Aus (i.e. farm harvest price of paddy during summer i.e. July to September) price and, (iii) the Aus price are considered. In the studies of Subbarao and Stern relative prices lagged one year has been considered as the prices relevant to farmers' decision on acreage allocation.

Group III: Studies Using Multiple Regression:

The studies using multiple regressions can be further subdivided into two. The studies using traditional models (those in which adjustment lag mechanism is not specified) and those using adjustment lag methods.

In one study by Rao and Jai Krishna, in which traditional regression model has been used, 12 different price expectation models have been tried. The acreage under wheat is regressed against the price index of wheat and weighted average price index of competing crops. The effectiveness of each expectation

31 M.S. Rao and Jai Krishna (I-74).
model is examined by applying five criteria\textsuperscript{32}. In the study by Satyanarayana the influence of four factors namely (a) installed capacity of sugar industry (b) relative mill price of sugarcane (c) relative yield of sugarcane and (d) relative price of gur, on acreage under sugarcane is examined by using a multiple regression model\textsuperscript{33}. Use of multiple regression without specifying the lag adjustment mechanism has been made in studies in other countries too\textsuperscript{34}.

Robert W. Herdt in his study which attempts to find aggregate supply response in Punjab uses multiple regression to estimate the relationship between the output of each crop and relevant prices and other factors that might shift the supply function of each crop. The aggregate elasticity is determined by using each of the estimated regression equations to predict the change in output of a given commodity due to one per cent increase in all agricultural commodity prices, holding prices paid by farmers constant\textsuperscript{35}.

\textsuperscript{32} The five criteria used by Rao and Jai Krishna are (1) Sum of ranks of yearly deviations from realized price (ii) average of the absolute deviations from realized prices, (iii) nature of positives and negative deviations from realized prices (iv) correlation coefficient (absolute values) between price of the models and realized price (v) overall ranking. See, also, Rao and Krishna (I-74).

\textsuperscript{33} Satyanarayana (I-77)

\textsuperscript{34} Gerald and Heady (I-13) also in their studies used a multiple regression without specifying the lag adjustment mechanism. While examining change in supply response and elasticity for hogs they used four variables including the margin between average price of all feeder cattle and average price of slaughter cattle.

\textsuperscript{35} R. B. Herdt (I-28).
The adjustment model reflects technological and/or institutional constraints which permit only a fraction of the intended levels to be realised during a short period. After the work of the Nerlove most studies make use of Nerlovian adjustment model. However, a few studies, notably of Bomesh and Griliches, make use of other adjustment models.

In the studies which have appeared recently, though the basic model used is Nerlovian adjustment model, they differ in respect of the other variables included in the regression equation and also with respect to price variable. Raj Krishna in his study includes relative yield, irrigated area, and weather, in addition to relative price and considers post harvest price lagged one year, as the price affecting farmers' decision regarding land allocation. D. Romesh in his other study makes use of Nerlovian adjustment model but no other shifter variable has been included in the regression equation and the price taken is the wholesale price index of the crop deflated by the wholesale price index of all other commodities.

While examining the supply response of wheat in U.P., Jai Krishna and M.S. Rao make use of Nerlovian model in addition to the above models.
to other models\(^{41}\). They make use of seven different models for estimating expected prices. N.C.A.E.R. in its study of responsiveness of area to price changes also makes use of Nerlovian adjustment models\(^{42}\). This study covers four important crops and makes use of state level data\(^{43}\). In the study by Chandresh Kumar also the basic model used is Nerlovian adjustment model\(^{44}\). The study concentrates on three districts of Meerut division of Uttar Pradesh, apart from the state as a whole. No other shifter variable like rainfall or irrigation have been considered in this study. Nerlovian adjustment model has also been widely used in studies pertaining to other underdeveloped countries\(^{45}\).

Let us examine in some details the Nerlovian models as they have been widely used. The basic Nerlovian model is a three equation model. The equations are\(^{46}\):

\[
\begin{align*}
(1) \quad x_k &= a_0 + a_1 p_k + u_k \\
(11) \quad p_k - p_{k-1} &= \beta (p_k - p_{k-1}) \\
(iii) \quad x_k - x_{k-1} &= \gamma (x_k - x_{k-1})
\end{align*}
\]

\(^{41}\) Jai Krishna and M.S. Rao (I-40)
\(^{42}\) N.C.A.E.R. (II-25)
\(^{43}\) Crops covered are wheat, paddy, jowar and gram.
\(^{44}\) Chandresh Kumar (I-48)
\(^{45}\) Falcon (I-19) in his study on farmers response to prices in Pakistan makes use of a modified Nerlovian adjustment model. Other users of this model OlmanSee (I-69) and Behrman (II-2). Olman examines the effect of price on acreage and yield of Potatoes. Behrman (II-2) in his study of Thailand uses expected price, relative standard deviation (as an indicator of uncertainty) total population etc. in addition to the variables taken by most users of Nerlovian model.

\(^{46}\) See Marc Nerlove (II-26)
The equation (i) relates the desired planted area to expected future price, while equation (iii) indicate that in each period actual planted area is adjusted in proportion to the difference between the planted and desired area, and similarly the equation (ii) indicates that the expected price is the price in the previous year plus \( \beta \) times the difference between the expected and realized price in the previous year.

The coefficients \( \beta \) and \( \gamma \) appear to simplify the complex phenomena of price expectation and acreage adjustment. Glenn L. Johnson while reviewing Nerlove's book rightly states, 

"...the price expectation models of farmers are conceptually more complex than simple primarily statistical models envisaged by Nerlove and others. Do we really believe that the next year's expected price is this year's expected price plus some proportion (constant from year to year) of the difference between last year's actual and last year's expected normal price regardless of wars, price support activities, inflations, economic collapse, changing foreign demand, strikes and institutional adjustments all of which were important in the year 1909 - 1932 period studied by Nerlove."

In fact it is difficult to assume that the value of \( \beta \) remains the same irrespective of whether prices have been increasing in the past, decreasing or have been constant over the year. Similarly since \( \gamma \) does not change from year to year, the acreage adjustment coefficient, \( \gamma \), appears to be incapable of handling the complex problem of acreage

47 Glenn L. Johnson (I-33).
adjustment on farms. In fact similar observations have also been made by others on the applicability of $\beta$ and $\gamma$ coefficients. These are limitations which the studies making use of Nerlovian adjustment model suffer from.

From the above review of studies pertaining to Indian agriculture the following main points emerge: (i) Invariably all the studies, except one by Robert W. Hardt, attempt to find supply response of individual crops rather than the aggregate supply response, (ii) All the studies except one are at the state level of aggregation, (iii) The price variables considered to be relevant for farmers' decision vary from one study to another, (iv) Since the lowest aggregation level is district in these studies it has been assumed that all the farmers expect the future prices to be in the same direction.

Results of the Studies:

The results obtained from a few of these studies particularly those using adjustment models are summarised in the appended table (No.II-1). Though, the results of different studies are not perfectly comparable, they differ not only with respect to specification of price variable but also with respect to the reference period etc. However, they may be considered roughly comparable. The table reveals that

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48 See for example Harold Watts (I-97)
49 Robert W. Hardt (I-25)
estimates of price elasticities for the same crop obtained in different studies or in the same study but in different areas differ significantly from one another. For instance, the price elasticity obtained by N.C.A.E.R. for wheat in U.P. is .068 while Jai Krishna and Rao obtained a long run elasticity of the order of .64. The price elasticities obtained for cash crops like sugarcane and cotton are not only positive but high also; on the other hand the elasticities obtained for food crops, though positive, are of small magnitude. Specially in the case of foodgrain crops it appears that the value of the elasticity coefficient depends to an extent, on the relative importance of the crop in the product mix. If the crop under consideration is a commercial crop in one area, the elasticity is higher than the elasticity for the same crop in an area in which it is subsistence crop.

**Farmers' Expectation of Future Prices:**

Studies on farmers' expectation of future prices are practically non-existent in this country. No systematic attempt has been made to know as to how do the Indian farmers attempt to forecast future prices. Many studies conducted in other countries, e.g. the United States, suggest that farmers do anticipates future prices. It has been found that for their

50 For example see, D.B. Williams (I-99), W.E. Williams (I-100), Heady (II-11), Schultz (I-80) etc.
forecast a majority of farmers do not use simple mechanical models such as the projection of current price or recent price trend into the next year but attempt to analyse and predict the more complex price making forces. D.B. Williams in his study on farmers' expectations found that all the farmers did not expect in the same way and there was a strong tendency among farmers to round off expectations of price to whole or near integers. In a study by W.F. Williams on dairy farmers similar type of results were obtained. It has been found that most farmers feel that all farm commodity prices usually move upward or downward together. It has been found in a study that the farmers not only project the past into the future but, at times, they try to adjust expected prices to the likely values of the other variables determining the prices.

To sum up, relatively more work has been done on supply response compared to the work on expectation behaviour though the study of expectational behaviour should have been given the first priority in supply response work. None of the studies focussed on Indian farmers makes use of constructive methods, in other words, in all the studies supply response has been examined by making use of statistical analysis of time series. Further, all the studies have been carried out at macro level. Use of statistical analysis of time series as a

51 Earl O. Heady and D.R. Kalder (I-26).
52 D.B. Williams (I-99).
53 W.F. Williams (I-100).
basic tool forced the earlier researchers to take very long periods and to assume that the expectations had been formed in the same way during the entire period covered by the study. In the same way the use of macro level data of acreage as proxy for production in almost all the studies made it obligatory to assume that all the farmers within the area covered by a particular study necessarily expected the future prices to move in the same direction. Whatever little information is available about the nature of farmers' expectation of future prices clearly indicates, that both the assumptions viz. that the expectation behaviour is invariant under different types of price situations and that all the farmers have similar expectations (expect in the same way), are open to challenge. The reliability of the estimates worked out in all these studies on supply response depends on the validity of these two assumptions. If these assumptions are not valid then the estimates of supply response found in these studies would be under-estimates or over-estimates of true supply response co-efficients. It is necessary, therefore, to find a new approach which can link the cross-sectional finding about the nature of farmers' expectation of future prices and the time series data of acreage and prices, for working out the estimates of supply response.