Chapter 10

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Surveys and Studies to Estimate Farmers' "Planned" or "Proposed" Supply Response*

SURVEYS AND STUDIES designed to estimate farmers' "planned" or "proposed" supply responses take us into areas where little is known. A farmer's planned supply response involves estimates of the future. Here, his knowledge is imperfect. Little is known about what these estimates of the future are, how they are constructed, and how they are integrated into a plan of action. We know that as the farmer formulates his plans, he is faced with imperfect knowledge about such variables as prices, technology, yields, institutions, and people. But we do not know how and to what extent these variables are considered in the farmer's planned supply response. Perhaps other variables (in an interfirm sense) such as subjective fixity of factors, age of operator, family composition, equity position, desire for leisure, and level of income, are the ones that determine his planned supply response. Moreover, as a farmer's planned supply response involves estimates of the future, these estimates are subject to error and error gives rise to differences between planned and realized supply response. Little is known as to the extent of this gap. A study of farmers' planned supply responses may uncover portions of supply response that are unplanned; that is, some of the changes in supply response may be due to random variation and little is known as to the extent of this variation.

Thus, in planning a study to estimate farmers' planned or proposed supply responses, we are unable to draw upon a well-developed body of theory. Perhaps, therefore, we had best initiate such studies on a limited scale with the primary purpose of gaining some information and insight as a basis for some meaningful hypotheses.

With this word of caution, the objective of this paper is to suggest how cross-sectional studies using survey techniques may provide estimates of supply response and/or supplemental information about a variable or variables used in other approaches to supply estimation, such as linear programming or time series. Although it is not our objective to evaluate critically or compare alternative techniques or procedures used in supply estimation, it is necessary to describe some of

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the problems associated with the use of linear programming and time series analyses. In our view, no one technique or procedure can provide us with all the knowledge we need about supply.

CONCEPTUAL FRAMEWORK USED AS A BASIS FOR DEVELOPING THIS PAPER

Before we can proceed toward our objective, it is essential to explain briefly the conceptual framework that serves as a basis for developing this paper. It is also necessary to point out general areas in which lack of data (and in some instances of theory) make this framework inadequate in the sense of possibly failing to provide reasonably accurate estimates of supply response.

As shown in Figure 10.1, changes in supply of a commodity can be viewed at both the firm and the aggregate level as consisting of two parts: (1) moving up and down a given supply function a_1, a_2, or a_3, in response to price, and (2) the growth or shift of supply (Δs_1 and ... Δs_2) through time accomplished by investment in plant or fixed resources and the adoption of those new technologies which over the relevant range in prices take on the form of investment in plant. Once adopted, they are often found to be profitable under a wide range in price and their use is not discontinued as prices decline. Thus, the growth or shift of supply over a wide range of prices is considered to be a one-way irreversible street, especially for those commodities whose production involves factors with acquisition costs differing significantly from salvage costs and with fixed costs making up a substantial part of total costs. It is recognized, however, that at some level of price, it is possible that the use of these technologies will be discontinued or the use of plant resources will be drastically reduced or used for other purposes, as shown by the dotted lines in Figure 10.1.

This elementary framework suggests the existence of pure price-quantity relationships. In the real world, we doubt that such pure relationships exist. We suppose that in actuality, supply response is related to a number of variables, among which price is one. This framework further suggests three closely related, though conceptually separable, areas in which critical information is lacking. First, while considerable farm management information is available as to what farmers "should" do to maximize profits in a timeless static sense, there is a paucity of information about the changes farmers plan and do make in time under conditions of uncertainty about prices and other variables. Second, we need more information about technological change, for example, the rate of adoption of existing technologies, the variables that influence adoptions, and the effect of such adoptions on factor combination and output levels. Third, we lack a theory of investment at the firm level. Worse yet, we need to identify the variables that significantly influence investment so they may serve as a

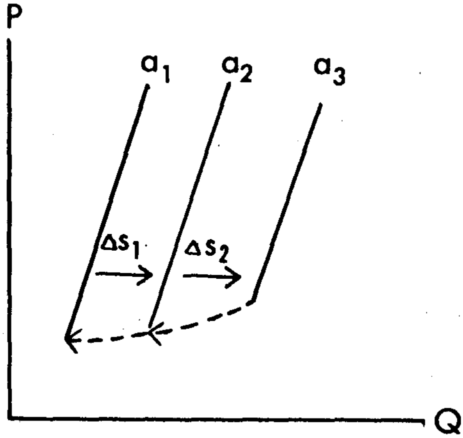

Figure 10.1. Changes in price-supply relations through time.

basis for constructing a theory of investment. Obtaining information on changes in asset structure through time by means of cross-sectional surveys may serve as a basis for formulating some meaningful constructs for building a theory of investment at the firm level.

SUPPLEMENTING LINEAR PROGRAMMING ESTIMATES OF SHORT-RUN SUPPLY

The authors are involved in the Lake States Dairy Adjustment Study.[1] Thus, our remarks are largely in terms of supply estimation for milk, although many of the implications are equally applicable to estimation for other commodities. Variable price linear programming techniques are being used in this study. They have been used in other studies to derive estimates of supply elasticity.[2] It is recognized, however, that the linear programming technique is inherently unsuited to the handling of lumpy variables, and the growth of supply referred to in Figure 10.1 often involves such "lumpy" variables as land, milking parlors, combines, tractors, etc.[3] Thus, we believe that linear programming as now known is essentially applicable only to a unique kind

[1] This study is being made by the Farm Economics Research Division, Agricultural Research Service, U. S. Department of Agriculture in cooperation with the Michigan, Wisconsin, Minnesota, Iowa and Illinois Agricultural Experiment Stations.

[2] See, for example, McPherson, W. W., and Faris, J. E., "Price mapping of optimum changes in enterprises," Jour. Farm Econ., 40:821-34, 1958; and Knudtson, A. C., and Cochrane, W. W., "A supply function for flax at the firm level," Jour. Farm Econ., 40:117-23, 1958.

[3] One way to overcome this difficulty is to program at different levels of lumpy variables, representing the same and/or different technology, and then comparing outcomes. This procedure, however, can result in numerous programming problems and hence may become prohibitively expensive.

of estimation of a short-run, timeless supply schedule. This estimation is of a unique kind because the linear programming model depicts the production behavior that would be rational if profit maximization is the goal or end and if the conditions within which this maximization takes place are realistically described within the model. The maximization of an end or goal subject to constraints is applicable not only to a profit goal. Conceptually, the profit goal can be replaced with another goal or set of goals. But if a multiplicity of goals is admitted, the economic calculation is not operational unless some weights can be attached to these goals. With the present state of our knowledge, there seems little possibility of determining these weights and hence little possibility of actually replacing the profit goal with a wide range of goals in the economic calculation. But another alternative is available. Instead of attempting to maximize some weighted set of goals, other goals could be considered as additional constraints in a profit-maximizing calculation. This could be accomplished if the effect of these other goals are reflected in the availability of resources for farm production, for example, credit capital availability in relation to willingness to borrow and labor availability in relation to willingness to work. Further, if the effects of these other goals on response to a change in price can be related to other nonprice variables, such as age, equity, and family position — possible variables associated with goals other than profit — in addition to the usual production matrix, then it is possible to develop a prediction of human behavior in this limited context. Thus, if goals other than profit maximization are closely associated with age, equity, and family composition, the effect of these other goals can be reflected by stratifying on age, family composition, and equity position.

It may be useful to illustrate briefly how differences may arise between what farmers do and what they could do if they were to follow the dictates of a profit-maximizing model. For example, a farmer who has decided to send his children to college may need to place high demands for income in the present relative to some future date. At low prices for his products, high demands for present income may be evidenced by willingness to work longer hours, which within the limits of his other resources may cause him to favor high labor-using enterprises even though returns per hour of labor are low. At higher prices, however, the resulting higher income may reduce the pressure for higher income and this reduction may be evidenced by unwillingness to continue working long hours. Thus the reservation price on his own output may be related not only to goals other than profit but also the price of the commodity he sells. More explicitly, the farmer's attitude toward the dairy enterprise or his unwillingness to work long hours may limit the dairy herd on a particular farm to 10 cows with milk at $3.50 per cwt., even though it would be profitable, as determined by the linear programming model, to expand to a 15-cow herd. But at a price of $3.00 per cwt. of milk, the increased pressure to maintain income may cause this farmer to work longer hours and expand his herd to 15 cows. Since linear programming solutions are often sensitive to changes in constraints, it is clear that failure to reflect the effect of other goals on availability of resources may change considerably the estimates of elasticity based on the analysis.

Determination of these modified constraints or the effect of other goals might be accomplished for a sample of farms by a questioning process. The objective of the questioning would be to learn from the farmer his estimate of what his response would be to a variety of price situations. As we are attempting to supplement estimates of supply relations obtained from linear programming and as we have argued that linear programming is appropriate only for estimation of short-run supply response, certain limitations must be placed on the kind of response. New investment in plant cannot be allowed. Such items as the number of cows, the number of sows, and the use of labor and operating capital would be allowed to vary only within the limits imposed by existing land, buildings, and major equipment and machines.

In structuring questions to learn what the farmer says he will do in response to different price situations, we need to start the farmer thinking about resources that may limit his ability to change. Thus, initial questioning might take the form of: (1) How many more cows, if any, could you handle with your present housing facility? (2) How many more cows, if any, could you handle with your present hay and pasture? (3) How many more cows, if any, could you handle with your present labor supply? These questions could then be followed by others to ascertain the existing livestock program and organization, the planned changes for the coming year, and reasons for these planned changes. We might then follow with questions as to their price expectations for each major livestock enterprise. In the context of this kind of a supply function, we have a price quantity point (point a in Figure 10.2) identified by an expected price of milk, planned production perhaps measured in terms of number of cows, and the expected or most likely price of other livestock commodities. In the sample with which we are dealing in the Lake States Dairy Adjustment Study, this would be the price of hogs. As we will be comparing the supply functions derived for different farmers, it is essential that each function be identified by the same expected price of hogs. The next question would be to solicit the planned response for milk production if an expected price of (say) $12 for hogs were held with the same degree of certainty as the farmer's expected price of hogs. The answer to this question would then identify the point designated as a′ in Figure 10.2. With this background information, the questioning then might proceed as follows: (1) If a higher (specified) price expectation for dairy were held with the same degree of certainty, what changes in organization would be made? (2) What higher price expectation would be necessary to cause the farmer to change his planned organization (with no change in plant)? (3) What changes would be made at that price? (4) How would these changes be accomplished (effect on other enterprises) and what limits the amount of change?[4] (5) Repeat the above process to determine the price at which no further changes would be made without changes in plant. Above this point, the short-run supply function is presumed to be perfectly inelastic. This same form of questioning would be repeated for prices below the expected price to develop the remainder of the step function below point a′ in Figure 10.2.

As step functions would be derived for individual farmers, these functions could be compared to determine whether age of operator, family composition, equity position, and other characteristics influence supply elasticity. If these characteristics do affect supply elasticity, a measurement of their effect through cross-sectional studies based on surveys can be used (1) to modify elasticities derived from a profit-maximizing linear programming model, or (2) to initially stratify farms on these characteristics and then have the linear programming computations directly reflect supply elasticities unique to groups of farms with different characteristics. In the first instance, we could more readily measure how and to what extent the modified elasticities improved linear programming as a predictive model. In any event, we should have more meaningful short-run farm-management guides, since the restrictions reflect those imposed by the farmers themselves rather than those imposed by research workers.

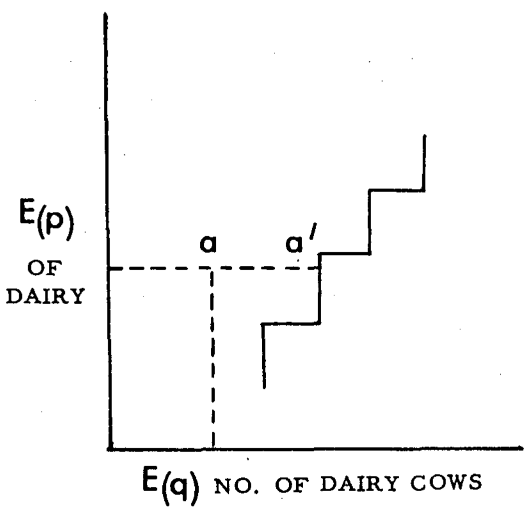

Figure 10.2. An expected short-run price-supply relations

[4] Statements on limits to change and how, if at all, these would be overcome would be checked against the farmer's response to how limiting various resources actually were to an increase in cows.

SUPPLEMENTING TIME SERIES ESTIMATES OF SHORT-RUN SUPPLY

A major problem in estimating supply response through the use of time series analysis is the ever-changing composition of agricultural firms — the movement of people out of agriculture, the recombination of land, capital, and labor, and the associated change in the age composition of the farm labor force. The effect of these changes in combination for a given set of prices undoubtedly changes the combination of enterprises and may change the effectiveness of price in bringing about changes in the composition of agricultural production. There is, of course, no guarantee that a cross-sectional interfirm study based on survey will overcome these problems; however, to the extent that such a survey analysis can identify the combination of firm and entrepreneurial characteristics associated with different magnitudes and kinds of production and the combination of characteristics associated with change and no change in production, it should yield information useful for improving time series estimates of short-run price-supply relations.

An examination of ten-year records of dairy-hog farms suggests that, while dairy cow numbers vary somewhat from year to year, on most farms this year-to-year variation is largely of a random nature. But, on some farms, there appears to be a definite trend in the number of dairy cows, suggesting that they are in process of going into or leaving dairy farming. It is the authors' hypothesis that those going out of dairying have a different combination of observable characteristics than those staying in dairying and hence changes over the years in the number of farms possessing these observable characteristics help to explain changes in dairy cow numbers and production.

Any attempt at identifying these characteristics involves a cross-sectional study over a period of years to (1) identify those farms having trends and (2) remove at least part of the effect of random variations in the number of cows from year to year. A continuing survey of a sample of farms or use of a "producer panel" for several years is an expensive undertaking. Certainly, if only a record of past production is obtained, the period required to allow isolation of the magnitude of random variation might be so long as to make the costs prohibitive. But by combining information as to planned production, actual production, and reasons for deviation between planned and actual production, the length of time perhaps can be greatly reduced.

For those farms having no observable trend in number of cows or no planned change in production, the analysis would proceed by relating the average production (number of cows) to certain firm and entrepreneurial characteristics. Preferably, these characteristics should be readily observable and attainable from other sources, as well as having some stability over time in an intrafirm sense. Certain firm and entrepreneurial characteristics are assumed initially to be stable or near-stable for individual firms over (say) a four-year period. These are age of operator, man-years of labor per 100 acres of land, long-run price expectations, type of farm in terms of a broad classification, and number of acres of land. Of these, age of operator, man-years per 100 acres, and number of acres of land are continuous variables in an interfirm analysis, while type of farm and long-run price expectations are discontinuous.

Any combination of variables that attempts to explain differences in the number of cows may take on a number of forms. The most simple and easily used is a linear form[5]

$$Y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 \mid x_4, x_5$$

in which: Y is total number of cows

x_1 is number of acres of land

x_2 is age of operator

x_3 is man-years of labor available per 100 acres (assumed to reflect family composition)

x_4 is long-run price expectations for dairy relative to hogs

x_5 is a broad classification of type of farm, such as dairy or dairy-hog

This linear form, in addition to simplicity in fitting, has advantages in simplicity of use. Ex post, if the number of farms is known, as well as the average value of each of these variables for the area in question, the linear equation can provide a preliminary estimate of the number of cows for the area. Thus, in a probability sense, that portion of the change in cow numbers associated with a change in structure of farms or in entrepreneurial characteristics can be isolated. Other forms, including products of two or more variables, or logarithmic functions, would require a considerable degree of disaggregation. For example, an equation with one term a product of two variables with a significant and sizable coefficient would require disaggregation to the point that the number of farms with each combination of the variables in the product term is known. The choice between functions must be determined largely by the comparative proportions of the total variation explained by the alternative forms.

To the extent that some farms indicate a trend or have made planned changes in dairy production, analysis beyond the foregoing can add to our information. First, it seems likely that those farms with increasing cow numbers would have a different combination of characteristics than those with decreasing numbers of cows. Hence, we need

[5] The simplified models presented here should in no way be considered as the only type of analysis that can or would be conducted in a cross-sectional study. We hope, however, that they will serve as a starting point from which more complex and more realistic models can be developed.

to know something about the combination of firm characteristics associated with positive changes, no change, and negative changes in cow numbers. Second, because changes in organization usually represent new investment in livestock, buildings and equipment, we need to know something about the investment function for farms making changes in organization.

The study of firm characteristics associated with change in production could be accomplished with an analysis similar to that suggested earlier for absolute production. To minimize the importance of small random changes from year to year, change in product (for example, cow numbers) can be studied as an average over some time period. The relationship can be expressed in this general form:

Average change in total cows = f (number of acres of land, age of operator, man-years per 100 acres, type of farm, long-run price expectations)

This relationship would need to be expressed for each type of farm and the particular long-run price expectations of the entrepreneurs on particular types of farms. Thus, we might have the above relationship for dairy and for dairy-hog farms with (1) long-run price expectations favorable for dairy but unfavorable for hogs (where favorable or unfavorable is defined relative to the date of the first survey), (2) long-run price expectations favorable for hogs but unfavorable for dairy, or (3) long-run price expectations for dairy and hogs similar to existing prices for hogs and dairy.

To illustrate the kind of information that can develop from study and analysis of these relationships, we hypothesize the relationship shown in Figure 10.3 between average change in cow numbers and number of acres of land for dairy farms with long-run price expectations favorable for dairy but unfavorable for hogs.

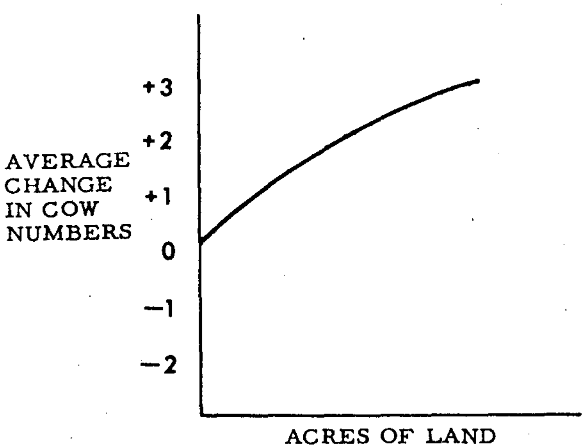

Figure 10.3. Relationship between cow numbers and acres of land.

This increase in number of cows represents new investment, not only in cows but possibly also in feed, buildings, and equipment for the additional cows. To the extent to which level of net cash income reflects the ability to make new investment, we suppose a positive relationship between new investment and income as illustrated in Figure 10.4.

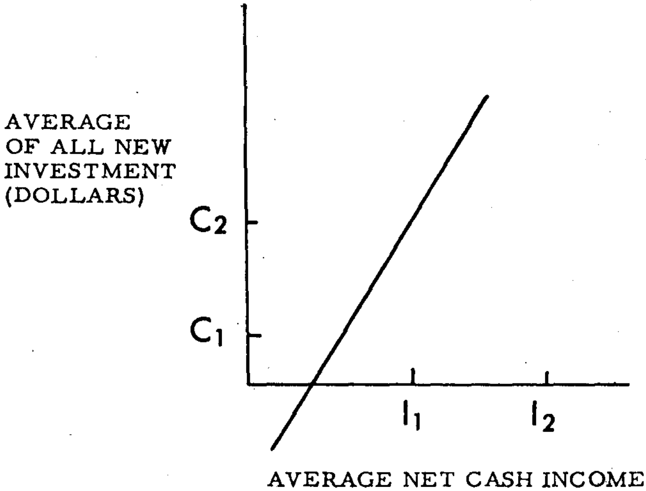

Figure 10.4. Relationship between new investment and net cash income.

With these relationships, price administrators (those for milk, for example) should be in a better position to estimate the effect of a milk price increase on new investments in dairy. Suppose, for example, that a milk price increase augments net cash income from I_1 to I_2. This increase in income is then expected to increase new investment from C_1 to C_2. To determine the effect of this new investment on milk production, we would need to know the relationship between average new investment and the increase in cow numbers as indicated in Figure 10.5.

Thus, with an increase in investment of $C_1 C_2$, we could expect an increase of 200 cows. With knowledge of average production per cow, we can then estimate the total increase in production expected from a given price increase.

To the extent to which an analysis of changes in product in relation to certain entrepreneurial and firm characteristics adds to our information on supply of production response, such information can be used to adjust the solutions from the equation

$$Y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 \mid x_4, x_5$$

(in which Y, or total number of cows, is a function of acres of land, age of operator, man-years of labor per 100 acres, given long-run price expectations and type of farming), when used as a first step in analyzing

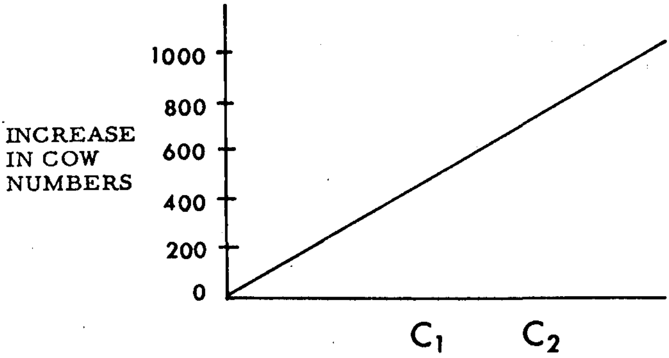

Figure 10.5. Relationship between change in cow numbers and new investment.

those farms evidencing some trend or directional change in cow numbers. Such information could be used also to adjust short-run price quantity estimates from time-series analysis. Empirical information on the composition of new investment may furnish a basis for isolating the part of a supply change that is due to a change in price and the part that is due to a change in investment that causes the supply function to shift. At present, such isolation is a bothersome problem in time series analysis. Moreover, empirical information on the investment process at the firm level can serve as a beginning foundation for constructing a theory of investment for the farm firm that can serve as a useful guide to both firm and policy decisions.

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Discussion

IN BUILDING supply estimates from the micro level, Jensen and Day present cross-sectional studies based on survey techniques. The authors have laid a sound groundwork for their proposal. Farmers make plans in an area of imperfect knowledge. This leads to errors in judgment, resulting in a gap between planned and realized supply response. In order to improve our estimates of farmers' supply response to changing conditions, we need better information.

Jensen and Day have called attention to three areas where critical information is lacking: (1) how farmers respond to changes in price and other variables under conditions of uncertainty, (2) the influence of a change in technologies, and (3) a theory of investment at the firm level.

Previous papers indicate some of the shortcomings of other methods of studying supply response at the micro level. Jensen and Day give emphasis, quite properly, to the difficulties in handling "lumpy" variables (land, equipment, etc.) in linear programming and the further difficulty in recognizing goals other than profit maximization. In time series analysis the difficulty stems from the "ever changing composition of agricultural firms." It is hoped that the proposed cross-sectional survey study would supplement and improve our estimates of supply responses.

Jensen and Day state their objective is to suggest how cross-sectional survey studies may be used to provide estimates of supply response, and to provide information about variables affecting supply response of the farmer, which would be helpful in other approaches to supply estimation. The proposed method would involve the preparation of a questionnaire for farm producer interviews. It might be necessary to make observations on some farms for several years in order to observe the characteristics of those farms where production is increasing and those where production is decreasing.

One question that might be raised regarding a survey to determine how farmers would respond to various changes in price is the validity of the information obtained. Will the farmers' response to the question, "What would you do if the price of milk increased 20 per cent?" be the same as the action he would take if prices really should rise 20 per cent? Is it likely that the farmer would be influenced by current conditions or experiences? Let us assume that the enumerator arrives for the interview (1) just after the farmer received the report that his was the top producing herd in the DHI Association, for the first time, or (2) toward the end of the day when everything pertaining to the dairy enterprise had gone wrong. Would we get the same response from farmers in either case? I am certain the authors recognize this problem. They experienced similar problems in the Interstate Managerial Studies.

The observations over a period of years to study the characteristics of farms that make changes in production could be costly and time consuming. The procedure could be justified on both counts if this technique is necessary to obtain the information. Such studies would have to be made in many areas. For example, in dairying the variables that influence supply response and their relative importance would probably vary among the dairy producing regions in the United States. It might be possible to obtain some of this information from farm record association cooperators where records are available for numerous farms for a number of years. This might reduce the cost and the time required to accumulate useful information.

The task of accumulating the information we need would be enormous if we relied entirely on the proposed survey method. Each major type of farming area might have to be surveyed for each important commodity. Jensen and Day do not suggest this use of the survey method. They want to use it on a "trial" basis to determine if this method could be used to provide better information than is available from other sources.

One important question pertains not only to the survey method, but to all procedures discussed. How can we determine the response of farmers who are not now producing the product in question? Taking dairy production as an example, we need to know how dairymen would respond to various increases in the price of dairy products. It is also important to know at what price other farmers would shift to dairying and how much they would add to total production at various prices.

In spite of the questions raised regarding the cross section survey method, it may prove to be a useful tool in our effort to determine the farmers supply responses and the variables that influence his decision. Any method that would help to shed more light on our problem merits careful consideration.