CONSIDERATION OF WEATHER IN FARM
PROGRAM PLANNING

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Since Cro-Magnon man took shelter from a storm in a cave near Dordogne, France, man has considered weather in his program planning. His consideration of weather in his planning grew when he learned how to invest time and effort in planting seeds so as to enhance his supply of food some months ahead. When man learned to invest at one point in time for his own benefit at a later point in time, he took one of the giant strides on the long road toward civilization. But the months between the act of planting and the enjoyment of harvest gave early man time to worry about the weather. He suffered with unfavorable weather and rejoiced with favorable weather. Thus, early man created rituals and prayers which he hoped would induce the favorable, and he devised charms and incantations which he hoped would avoid the unfavorable. He lived with forces beyond his control and he planned as best he could to avoid disaster.

We pride ourselves on having greater sophistication than our savage forefather, but, like him, we are still concerned with weather and our food supply. This seminar itself is evidence of our concern. Like primitive man we still live with a force largely beyond our control, but unlike primitive man, we have an immensely more complex setting for our concern regarding the effects of weather on our food supply.

When the first farmer's seed froze in the ground or his crops withered in drought, only he and his family went hungry. Today our failure to take weather properly into account may not have such drastic effects on us as individuals, but may have more far-reaching effects on the well-being of vastly greater numbers of people. The vagaries of weather can affect the price of groceries a thousand miles from the scene of a storm. More importantly for our purpose here, weather can affect the effectiveness of farm programs and their costs.

Agriculturalists are interested in weather for many different reasons. Farmers are interested in the production risk and the effect of bad weather on income. Agronomists are interested in the stresses plants must survive. Statisticians are interested in improving the accuracy of forecasts of crop production. Insurance firms are interested in the likelihood of losses. Conservationists are interested in erosion and stream flow problems. These are a few examples; there are many others. My interest in this paper is in the relationship of weather to total farm output and thus to the planning and operation of farm programs.

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We experience and observe problems in our agricultural industry; many of these grow out of the relationship between supply, demand and price of major farm commodities. We strive to design programs that will alleviate the observed problems. We seek authority and funds from the Congress to initiate and operate programs. In observing problems, in designing programs, in discussing the merits of programs in the Congress and in operating programs we make estimates and projections regarding the chief variables. A most important variable is volume of output.

If we underestimate future output under any given program situation, we find either that the program does not accomplish its intended goals or that it costs more than anticipated. If we overestimate future output, we risk possible shortages of a commodity and inefficiency in the use of public funds for program purposes. Thus, estimates and projections become crucial ingredients of program planning, enactment and operation.

Mark Twain observed that everyone talks about the weather but no one does anything about it. Under currently available technology we cannot do much about the weather in farm program planning, but it is imperative that we "consider" weather seriously in several respects. Before I discuss the ways in which we do, or should, consider weather, I should first give my interpretation of the terms "farm program planning" and "weather."

For purposes of farm program planning, I define weather in the "weather index" sense described by Messrs. Shaw and Durost in their paper for this seminar. Essentially, this regards weather as the net effect on production of variations in environmental factors which are neither under control of the individual farmer nor in constant supply over time.

Concern with weather in farm program planning presupposes something about farm programs. Here farm programs are defined to include actions of government that affect the supply and price of major farm commodities. Planning for such programs includes the projections and analyses which provide a basis for judgment regarding the effectiveness and efficiency of programs in achieving accepted goals. Such economic analyses include many facets. Chief among these are projections of: market demand, both domestic and foreign; production response, in terms of both crop acreages and yields; impacts on incomes to farmers and costs to consumers; and probable costs of programs to the government. Considering farm programs in the broadest context, the time horizon of our projections and economic analyses may range from one to two years to 20 or more years.

Of the major facets of farm program planning, weather considerations relate almost exclusively to production response. Relatively small errors in projecting production response, for whatever reason, can have substantial
economic consequences. Given the relatively inelastic demand for farm products of U.S. agriculture, relatively small changes in output produce major fluctuations in farm prices and income, or they produce wide variations in government costs of farm programs. Obviously, failure to take account accurately of weather can be a major source of error in projecting the volume of production that may be forthcoming under any given farm program.

Projecting Production Response

Economists generally agree that projections of production or of production response to programs is one of our most complex and difficult areas of analysis. Changes in technology and variations in weather are two of the chief factors contributing to this difficulty and complexity. Further complicating the analytical problem is the fact that technology and weather are not independent variables; they are becoming increasingly interdependent.

In considering the weather-technology interaction in production response, we ideally would like to become a combination of the proverbial bird that flies backward to see where he has been, and the seer with a telescopic crystal ball.

Our history of prediction has been none too bright since the advent of modern farm programs more than 30 years ago. I doubt that we have done much better than Joseph who foresaw the seven fat years and the seven lean years. Joseph, at least, was not confounded by a rapidly changing technology of production. Technical change has pushed our aggregate supply curve rapidly to the right. In program planning we have rather consistently underestimated the scope of the adjustments needed to achieve some semblance of balance between production and disappearance of farm commodities. By using output-increasing innovations farmers themselves have proved us wrong with great consistency.

For this and other reasons we failed for a long while to provide for programs big enough to achieve the adjustments needed in agricultural production. Furthermore, we found programs costing much more than anyone predicted because either the volume of commodities that came under price support was greater than estimated or the dampening effect of land retirement was less than estimated. The need for more reliable ways to project output of major commodities is obvious to all students of agricultural policy.

Since the two chief forces affecting trends in output are technological change and weather, we need to untangle, as best we can, the impacts of technological change and weather variation on production in past years. It is essential that we gain a clear picture of the time path of adoption of that bundle of farm practices we label technology. The latter step is a prerequisite to analysis of factors which influence the rate of adoption of technology and to projections of the effect of this controllable factor on farm production. As Shaw
and Durost emphasize, a weather index of some kind is required to achieve this goal.

Even if we could explain perfectly the past weather, technology and production relationships, weather would still plague us in projecting production response to farm programs in the future. The problem of forecasting weather effects into the future remains. Thus, the effects of weather limits accuracy in farm program planning. However, more adequate measurement of the effects of weather and technology in the historical sense would represent major progress. With it, we could project technology and its impact on production with more assurance. Also, knowledge of the range and probability of occurrence of weather and its effect on production in the past would provide the basis for developing features in a farm program that would minimize the economic impacts of unforeseen weather variation.

I have suggested ways in which we should like to consider weather in analyses of production response and in farm program planning. Let us consider these ways in which we have considered weather.

Trends in Crop Yields

In recent farm program planning, weather entered the analyses chiefly as it affects yields of crops. Even here, we have considered weather only in an indirect manner because of the lack of a comprehensive way to distinguish relative effects of the various forces affecting production. In practically all instances, our basic approach in program development has been to project yields of major crops by extrapolation of linear trends in yields since 1950.

Several modifications of this basic approach have been used:

1. In cases where wide ranges in acreages of an individual crop were indicated under alternative program assumptions, the level of the projected yield has been adjusted to account for land selectivity and probably shifts in regional location of acreage.

2. Similarly, the probable impact on production practices of farmers occasioned by wide ranges in price assumptions for an individual crop has been recognized and reflected in adjustments of projected yields.

3. Also, specific knowledge of unique conditions regarding technology or weather conditions in recent years has been used to modify the linear trend in our final projections of yield. Grain sorghum is one example of the latter; here, knowledge of recent rapid adoption of hybrid seed provided the basis for moderating the sharp increase in yields indicated by the linear trend.
Over all, the net effect of these various adjustments to linear trends has been relatively small. For practical purposes, our technique is basically one of projecting linear trends fitted to the yield experience since 1950. Obviously, we would prefer to use more sophisticated approaches if proven technology and adequate data were available. Although, superficially, our technique may appear overly simple and too prone to major errors in projections, it has a substantial rationale. Several factors support this conclusion:

1. Our analyses have been concerned chiefly with U.S. agriculture as a whole. Acreage of most of our major crops is widely distributed geographically. Widespread droughts and widespread good weather are rare. On a national basis we normally can expect compensating effects on yields of weather variations among regions in any given year. Casual inspection of the maps shown in the monthly "Crop Production" reports of the Statistical Reporting Service for the last several years illustrate this pointedly. The maps show that each year we have a mixture of areas ranging from "extreme drought" to "excellent" growing conditions.

As a nation we are fortunate that our agriculture is widely distributed and that all of our major commodities are grown over widely varying climatic zones. This provides much greater stability of production than many other countries enjoy. By contrast, most of Canada's wheat is grown in the Prairie provinces. Growing conditions are hazardous, so Canada's production of wheat varies from year to year tremendously more than ours.

2. We grow crops over wide ranges of climate and weather; we also grow a wide variety of crops, many of which are substitutes for each other. Each crop responds differently to weather. Thus, there are compensating errors in projections of yields of crops which are close substitutes in total farm production. Projection of yields of the four feed grains -- corn, grain sorghum, oats and barley -- is a good example of this. (And for purposes of analysis of some alternative farm programs, wheat can be regarded as a "feed grain" and added to the list of close substitutes.)

3. There is a growing body of evidence that rapid adoption of technology is the dominant factor in increasing yields. Available data on changes in farmers' use of fertilizer, improved seeds, pesticides and other key inputs of modern farming point in this direction. The supply equation reported by Shaw and Durost in their paper gives excellent statistical evidence of the dominance of inputs in explaining the rise in yields of corn in the Corn Belt.
(4) Although more research is needed on the subject, it is clear that progress in technology has dampened the effect of adverse weather on crop yields. Good weather releases the potential of technology and good technology dampens the effect of bad weather. Farmers have more power and better machinery than formerly; so seedbed tillage, planting, cultivation and harvesting can be done in time to take better advantage of the season. Plant breeders have built better drought resistance and winter hardiness into our crops. Irrigation is more widespread and is done better than it used to be. Better forms of fertilizers and better techniques for using them are a part of the picture. These and other innovations tend to reduce the damage from adverse weather.

(5) A considerable stock of unused technology exists as a basis for a further rise in crop yields over the intermediate period ahead. For example, Corn Belt farmers who cooperated in the variety tests described in the Shaw-Durost paper have attained yields of corn 25 to 35 bushels above the average reported for these states in recent years. Because of their willingness to cooperate in the variety tests, it seems logical to classify these farmers in the upper range of users of advanced production practices. Also, the cooperators are widely distributed geographically over the Corn Belt. Hence, comparison of their levels of corn yields with average attainment provides some measure of the existing stock of unused technology.

(6) Closely related to the last factor is the mounting evidence of acceleration in the rate of adoption of improved technology by farmers. The continuing rapid shift to fewer, but larger commercial farms is undoubtedly upgrading the level of management in U.S. agriculture. This structural change in the type and size of farms that together constitute American agriculture also points to an increasing ability of farmers to acquire and use the inputs that increase production. Further, our widespread studies of profitable adjustments on representative farms show, almost universally, that it would pay the individual farmer to adopt improved practices to a greater extent. These studies show also that further adoption of improved practices would be profitable to the farmer under a relatively wide range of price-cost relationships. Given the increasing quality of management, improved ability to provide purchased inputs and the profit motive to the individual farmer, we can expect an acceleration in the rate of use of available technology in the years ahead.

For these six reasons, we feel reasonably comfortable in the reliance we have placed on extrapolation of linear trends as a basis for projecting yields in program planning. Actually we feel that our technique of projecting
crop yields on the basis of trends since 1950 are likely to understate rather than overstate future yield achievements. In the past, use of our technique of projecting yields would have grossly underestimated yield levels in subsequent years. A chart prepared in the Farm Production Economics Division graphically illustrates this. (See chart.)

Linear trends were fitted to the index of crop production per acre for each decade beginning with 1910-20 and ending with 1950-60. Extrapolation of trend lines for each decade since 1920 suggested future levels of yield which significantly undershot actual yields in the following years. The record levels of crop production per acre achieved in 1961-63 strongly suggest that extrapolation of the 1950-60 trend will repeat the historical error.

Concluding Observations

Of necessity, we have placed perhaps too much reliance on analysis of national aggregates in our farm program planning. Rather, our aim should be to determine the nature, causes, location and importance of current and emerging maladjustments in agricultural production and to evaluate alternative programs designed to prevent or to alleviate maladjustment. We need especially to give more attention to the complex relationships among crops and among regions. This would sharpen our understanding of the effect of alternative programs on the allocation of production and resources within and among farms and regions. The Farm Production Economics Division recognizes the basic importance of this type of research. A recent reorganization of our Division's research program provides for much greater emphasis in this area.

In developing our research and in making it more useful in farm program planning, I am sure that we will have to give greater "consideration" to weather than in the past. A more comprehensive system of weather, indexes, covering at a minimum major crops and broad regions, will be a basic requirement for the research program we envision.

At the same time we need greater emphasis on measurement of the impact of technology and other nonweather factors on future yields, perhaps even more than we need improvements in our ability to measure the impacts of weather. But until we have a firmer basis in research and improved and more comprehensive data, our present methods of considering weather in farm program planning will have to suffice.
CROP PRODUCTION PER ACRE*
Past and Prospective Trends

% OF 1947-49

TREND

'50-60

'40-50

'30-40

'10-20

'20-30

1910 '20 '30 '40 '50 '60 '70

*Cropland Used for Crops

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