Evaluation of the Importance and Magnitude of Agricultural Maintenance Research in the United States

by

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(ABSTRACT)

The United States has invested substantial resources in agricultural research since the Morrill and the Hatch Acts. These investments have made American agriculture one of the most productive in the world. Several studies have evaluated U.S. agricultural research. However, few of these studies have attempted to assess the decline in agricultural productivity that would have resulted in the absence of agricultural research. The purpose of this dissertation is to measure the magnitude of agricultural maintenance research currently or recently undertaken to forestall such productivity declines.

A two part procudure was used to evaluate the importance of maintenance research in U.S. agriculture. First, questionnaires were mailed to agricultural scientists at the state agricultural experiment stations. The information sought from the scientists included examples of maintenance research and research depreciation, their annual research budgets, and the percentage of their research efforts devoted to maintenance research. The second part of the procedure was to estimate a profit function model to assess the importance of research depreciation in U.S. agriculture and to test the overall length and shape of the research lag. Duality theory was used to obtain the output supply (foodgrains, feedgrains, other crops, hay, livestock, and poultry), input demand (feed, fertilizer, fuel, and labor) equations. The fixed factors included were land, research, extension, education, capital, and breeding stock. Secondary data, from various sources, were used to estimate the equations.

The results from the responses to the questionnaire indicate that, on average, the United States devotes roughly a third of total agricultural production research to maintenance research. In addition, there are significant differences in maintenance research among individual commodities.

The results from the output supply equations indicated that the impact of agricultural research on agricultural output rises and then declines for some commodities. Also, research depreciation occurs for some agricultural commodities and maintenance research may be required to prevent productivity from declining. However, the results were for the most part, not statistically significant, reducing the strength of the conclusion that can be drawn.

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This dissertation is dedicated to my deceased father.

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The capacity to develop and to manage technology in a manner consistent with a nation's physical and cultural endowments is the single most important variable accounting for differences in agricultural productivity among nations. The development of such capacity depends on many factors. These include the capacity to organize and to sustain the institutions that generate and transmit scientific and technical knowledge, the ability to embody new technology in equipment and materials, the level of husbandry skill and the educational accomplishments of rural people, the efficiency of input and product markets, and the effectiveness of social and political institutions.

Vernon W. Ruttan, *Agricultural Research Policy.* University of Minnesota Press, Minneapolis, 1982, (p. 1)

Chapter 1

INTRODUCTION

The Morrill Land Grant College Act of 1862 and the Hatch Agricultural Experiment Station Act of 1887 created a dual federal-state approach to agricultural research in the United States. These Acts provided funds for a college of agriculture and mechanical arts and an agricultural experiment station in each state. This set in motion the program of publicly supported agricultural research in the United States. By 1985, total expenditures for agricultural research was $1.1 billion at the state experiment stations and almost $2 billion for all public agricultural research.

The success of this system of investment in science is evidenced in the doublings and triplings of yields that have made American agriculture one of the most productive in the world. These increases owe much to the pioneering work of the stations on pest control, hybrid plants, fertilization, irrigation, and other mainstays of modern farming (Budlansky).

With the sizable amount of public funds going to agricultural research, there was a need to assess the contribution of research to agricultural productivity. The initial research evaluation studies were conducted by Schultz (1953) and Griliches (1958). Since then there have been several studies to evaluate agricultural research, most of which have used consumer-producer surplus and production function analyses to assess the economic rate of return to society as a result of investments in agricultural research. Ruttan (1982) provides a recent summary of many of the studies, most of which have found high rates of return. Few of these studies, however, have attempted to assess the decline in agricultural productivity that would have resulted in the absence of agricultural research. While much of agricultural research has served to increase the productivity of U.S. agriculture, some portion of that research effort has been needed just to maintain previous gains. The main focus of this study is to measure the magnitude of such maintenance research.

1.1 The Problem

Most agricultural research is geared towards increasing agricultural output. The research effort usually is directed at increasing the productivity of inputs. However, research effort also is needed just to conserve or to maintain yield levels. This is because research output depreciates over time due to evolution of resistant pests and pathogens, plant varietal deterioration, and other factors. Maintenanace research renovates or replaces deteriorating research information. Many scientists have alluded to the importance and the magnitude of maintenance research, Ruttan (1982), Peterson and Fitzharris, and Plucknett and Smith. However, there has been very little research designed to measure the importance of maintenance research. The magnitude of research depreciation and maintenance must be accounted for if the value of agricultural research programs are to be adequately assessed.

Depreciation is one component of the temporal distribution of the impact of agricultural research. There are lags between research expenditures and research output, production of research output and its adoption by users, and depreciation of research output. Beginning with the seminal work by Evenson (1968), many researchers have included the inverted-V shape or Almon quadratic distributed lags in their econometric efforts to explain the temporal distribution of agricultural research benefits. Unfortunately, these and certain other distributed lag procedures impose rigid restrictions on the nature of research depreciation.

Recent work by Pardey (1986) casts serious doubt on the validity of many of the lag priors assumed in previous research evaluation studies. Furthermore, both the magnitude of research depreciation and the overall length and shape of the research lag is likely to vary by commodity. Consequently, there is a need for careful study, disaggregated by commodity, of the magnitude of research depreciation as one component of the overall research lag.

1.2 Objectives of the study

The purpose of this thesis is to examine conceptually and to quantify empirically the nature and magnitude of maintenance research and the structure of the lags involved in agricultural research. Specifically, the objectives are:

1. to examine the relative importance of maintenance research in relation to total agricultural research, and

2. to examine the shape of the lag of the impact of agricultural research on agricultural output.

1.3 Hypotheses

The hypotheses to be tested in this study are:

1. that maintenance research is an important component of total agricultural research in the United States (for purpose of hypothesis testing, the definition of important is arbitrarily set at 25 percent of total research),

2. that the importance of maintenance research as a proportion of total research, varies substantially by commodity group, and

3. that the shape of the lag of the impact of agricultural research on agricultural output increases at an increasing rate, then at a decreasing rate, reaches a maximum, and then declines.

1.4 Procedure

A two part procedure is used in this thesis to assess the importance of maintenance research in U.S. agriculture. First, questionnaires were sent to agronomists, plant pathologists, entomologists, animal scientists and other scientists at state agricultural experiment stations. In the questionnaires, maintenance research was defined as the research efforts needed to prevent productivity levels from declining. The questionnaires asked for examples of maintenance research in the scientists′ fields, when research depreciation occurred, and the types of research needed to affect the depreciation.They were asked a series of questions about how long the research took, how much it cost, and if it was successful. The questionnaire asked what percentage of the scientists′ research funds were devoted to maintenance research activities.

The results of this survey provide a broad representative picture of the types and amounts of maintenance research being conducted in the U.S. for different commodities. Secondly, they provide a set of hypotheses related to the relative importance of maintenance research by commodity which are then formally tested following the estimation of an econometric model for U.S. agriculture. A profit function model is then employed to estimate the importance of research depreciation by commodity groups in U.S. agriculture and to test the overall length and shape of the research lag. The procedure entails estimation, using a flexible functional form, of a set of input demand and output supply equations. This procedure allows a critical look at the relationship among inputs and between inputs and fixed factors. One fixed factor, research, is lagged using alternative flexible distributed lags to measure the shape and magnitude of the research lag.

1.5 Organization of the Dissertation

The next chapter reviews and critiques previous studies on maintenance research and the impacts of research on agricultural productivity. First, conceptual issues associated with maintenance research and the lags involved in agricultural research are discussed. Examples of maintenance research in the United States and elsewhere based on a literature review are presented. Chapter three is a detailed discussion of the methods used in this thesis to examine the objectives and test the hypotheses presented above. Chapter four presents the results and interpretation of the scientists survey and chapter 5 presents the results of the econometric model. The final chapter comprises the summary of the dissertation, its implications, and suggestions for future research.

Dramatic gains in crop yield can be ephemeral unless a follow-up research program is in place to shore up the advances. Stable yields and sustainable agriculture are as important as raising the yield ceiling of crops....Upholding yield gains is the core concept of maintenance research.

Donald L. Plucknett and Nigel J.H. Smith *"Sustaining Agricultural Yields"* BioScience Vol. 36 No. 1 January, 1986, p40.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter is divided into two sections. First, a conceptual discussion of maintenance research and the lag involved in agricultural research is presented. Examples of maintenance research are enumerated. Second, empirical studies which have estimated the importance of maintenance research and the lag structure of the impact of agricultural research on agricultural productivity are discussed and evaluated.

2.2 Maintenance Research

2.2.1 Conceptual Issues

In the United States, farmers historically planted a mosiac of traditional varieties as insurance against outbreaks of diseases, pests, or severe weather and to exploit the potential of different environments. Agricultural production also was safeguarded by growing more than one crop, or several varieties of the same crop, in a field. Productivity was modest but relatively stable. The advent of modern plant breeding has changed a number of factors on the farm.

Gradually, a monoculture has emerged in the United States and associated with it a tremendous increase in productivity. Barker et al. point out that although yields have generally increased, productivity has become less stable. Modern cultivars usually yield better under optimal conditions than traditional varieties, but they are increasingly being planted in areas subject to severe environmental stresses (Plucknett and Smith). Because of these environmental stresses, the output of research deteriorates. Maintenance research can then be used to renovate or replace deteriorating research information. The research effort is needed to sustain productivity and dampen oscillations in crop and livestock yields. Upholding productivity gains is the core concept of maintenance research. It applies equally to monoculture and mixed farming systems.

Plucknett and Smith discuss some principles in maintenance research, particularly related to crop research. They suggest that a major principle is that as yields rise, so must the effort devoted to sustaining the gains. Some feel that when improved breeding techniques are applied to a crop, gains are typically easiest to achieve during the early years; thereafter, research must intensify just to give the same yields. As the yield curve flattens, the proportion of research absorbed by maintenance research rises (Evans). This "principle" is a testable hypothesis, although it will not be tested in the current thesis.

The history of the yield of several crops appears to illustrate this principle of the need for increased maintenance research over time. In the United States, yields of wheat, sorghum, potatoes, cotton, sugar beets, field beans, and peanuts have virtually levelled off after soaring in the 1950's and 1960's (Wittwer). Hawaiian sugarcane yields were virtually stagnant for 13 years until they rose again in 1984 (Heinz). It is not surprising, then, that some have suggested that about half of the research funds spent on wheat, cotton, peanuts, tobacco, citrus, potatoes and fruits, nuts and sugar crops in the United States experimental stations are for maintenance research - controlling pests, diseases and weeds (Evenson 1982). Plucknett and Smith reinforce Evenson's observation by pointing out that today a substantial amount of the funds spent on wheat research world-wide must go towards maintenance research.

A second principle is that maintenance research is especially important where crop pests and pathogens reproduce throughout the year. It is, therefore, critical that follow-up research be conducted in the tropics where year-round warmth permits more generations of arthropods and pathogens.

Another major principle is that resistance to environmental challenges is more durable when more than one gene responsible for resistance has been incorporated into a variety. Yield gains based on a single gene are normally more tenuous because it is easier for a pest or pathogen to overcome the obstacle. When breeders are limited by a restricted gene source, single genes can be rotated when developing new cultivars, thereby reducing the opportunities for pests to overcome the crop's resistance and this can help reduce yield instability.

Finally, yields are likely to be more stable when resistance to a broad range of diseases and pests, as well as tolerance of adverse weather, has been incorporated into a variety. It is difficult to pyramid desirable genes against a wide array of environmental challenges, but even multiple gene resistance to a single disease is unlikely to provide a solid foundation for sustained agricultural production.

2.2.2 *Examples of Maintenance Research*

Numerous examples of maintenance research are found in the literature. It appears that there is a need for research on several fronts to maintain a productive agriculture over long periods of time. For example, soil erosion is a worsing problem and research into appropriate preventive and corrective measures is necessary to protect the productivity of farmlands (Brown et al.). Much of the research on herbicides, insecticides, hybrids etc is also necessary for productivity maintenance. The examples to be enumerated below, many of which are summarized from Plucknett and Smith, address these and other research areas.

Evidence of the existence of maintenance research dates back to the 1920's. "During the period 1921 - 1942, races 2 and 5 made up approximately 97% of the isolates of stem rust, Puccinia graminis avenae (a rust affecting oats), collected in the United States. Races 8 and 10 on the other hand, were during this period relatively rare. By 1948, however, races 8 and 10 were the most common races of stem rust. This increase of races 8 and 10 with corresponding decline in the hitherto common races 2 and 5 is almost certainly due to the screening effect of the vast acreage of Richland and Victoria x Richland derivatives susceptible to races 8 and 10 but resistant to races 2 and 5."[1] The D69 x Bond derivatives were being developed for this reason and fortunately they were resistant to Victoria blight (Stevens and Scott). They concluded that a new oat variety will be needed in the Central Corn Belt every 4 or 5 years.

The National Academy of Science points out that *Helminthosporium mayids* (the fungus responsible for the 1970 corn leaf blight) had been present in America but died out because American corn was too variable to give the strain a very good foothold. The introduction of Texas cytoplasm (a high yielding variety of corn developed in the 1950's) changed all this. Corn was now nearly uniform throughout the country. The fungus continued to mutate. In due time, one of it's mutant forms

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[1] Stevens, N. and Scott, W. *How Long Will Present Spring Oats Varieties Last in the Central Corn Belt* Agronomy Journal Oct. 1949

proved ideal for Texas cytoplasm and spread like wildfire across the cornfields. This forced seed companies to introduce hybrids based on other parents the following year. This example supports Pimm's point that commercial farms are biotically simpler than traditional polycultural gardens and thus potentially more unstable.

Scientists have noticed that generally , modern cereal grains, especially wheat, have only a limited lifespan before they are attacked by fungal diseases. Varieties are now being replaced systematically by new varieties before they are expected to be in danger of failure (Bremermann). Over 400 species of agricultural pests are now resistant to one or more pesticides, and in the 1940's around 7 percent of all U.S agricultural crops were lost to insects, whereas the corresponding figure is now 13 percent (May).

An example of replacing a variety before a pathogen spreads is the following. A new race of *Cladosporium fulvum Cke.*, the tomato leaf mold pathogen, appeared on the tomato lines Purdue 135 in commercial greenhouses in the vicinity of Cincinnati, Ohio, in the fall of 1962. Experiments conducted indicated that varieties such as Vetomold, Tucker's Forcing, and Manlucie were accordingly immuned to race 10 of the pathogen. These varieties were substituted for the susceptible ones to control the spread of the pathogen and sustain yield levels (Bailey and Kerr).

Another example is on Hawaiian sugarcane. When sugarcane smut *Ustilago scitaminea* arrived in Hawaii in 1971, the Hawaiian Sugar Planters' Association (HSPA) scientists had resistant material in their germplasm that they immediately introduced into their breeding program (Ladd et al.). Instead of a sharp decline in sugarcane yields in Hawaii, there was hardly any effect by this highly destructive disease. The HSPA is also prepared to face the possible arrival of Fiji virus, another virulent pathogen of sugarcane. Fiji disease, which is transmitted by planthoppers, is a particular problem in Australia and Fiji, and the vector is present in Hawaii. The HSPA has resistant canes in its germplasm collection should the virus turn up in Hawaii (Plucknett and Smith).

There has been a similar preventive medicine type of sound maintenance research in the international arena. Various high-yielding cultivars of rice have been susceptible to pests and insects for a number of years. A recent example is that IR36 was planted in South East Asia in 1977 and 1978 to resist the brown planthopper. But, by 1982, new hopper populations emerged and fortunately researchers at the International Rice Research Institute and the Philippine national program were prepared for changes in the hopper populations. IR56 was multiplied in Indonesia to replace IR36, and IR60 was released in 1983 for use in Mindanao (Chang).

Cocoa is a tropical crop grown in West Africa, South America, and the Caribbean. This crop has been plagued by a host of diseases. The most devastating in South America, Panama, and the Caribbean is witches′ broom *Crinipellis permiciosa.* Although the fungal pathogen does not occur in Costa Rica, breeders at CATIE (Centro Agronomico Tropical de Investigacion y Ensenanza) near Turrialba, Costa Rica have taken the precaution of incorporating resistance to the disease in varieties developed for release in that country. CATIE scientists have used their germplasm collection of 506 cacao varieties maintained at the Lalola substation as a source of resistance to witches′ broom (Plucknett and Smith).

Soil erosion began attracting national attention in the United States in the early 1930′s. Since then a number of research projects have been conducted to estimate the amount of erosion occuring nationally. Erosion has developed into a serious problem and a recent national workshop sponsored by ten scientific societies cited ″sustaining soil productivity″ as their first research objective (Larson, Pierce, and Dowdy). The authors point out ″National increases in row crops at the expense of hay and pasture crops, particularly on steep slopes, have made the control of erosion a difficult prospect... The maintenance of a cropland base adequate to our needs must be a primary national goal.″ The thrust of on-going research is to ascertain the seriousness of current soil erosion with respect to long-term food and fiber production.

Environmentalists have sounded serious warnings about the consequences of the use of pesticides and herbicides. ″Many modern practices not only defy the natural strategy of polymorphism but pollution and the chemical warfare against pathogens may aggravate the problem and create further imbalances."[2] This has prompted a search for pesticides that may be less lethal for natural enemies than for pests, or even for the release of natural enemies that have been artificially selected for resistance to specific pesticides.

In recent years, new types of biotechnology research have emerged in an effort to maintain and/or increase productivity more efficiently. As the limit to "harvest index" is approached, genetic gains in yields will depend on detecting and exploiting genetic variation in biomass production (Austin et al.). Researchers interviewed in a recent study pointed out that genetic engineering technology may be able to speed up the process of plant breeding (Menz and Neumeyer). This has important implications for the speed with which maintenance research is performed.

In agriculture, nitrogen and carbon metabolism have been investigated and recombinant DNA techniques for gene isolation have been applied to a wide range of crop species. Another active area of molecular biological investigation is the level at which genes are controlled in the defense mechanism of plants against diseases and stress as well as in the normal development of plants.

These and many other types of research are efforts to seek new technologies to increase but also to maintain the productivity gains that have been achieved in agriculture. In other words, these are research efforts which in the future can be used to counter threats to declines in productivity. However, agricultural biotechnology is far behind medical biotechnology although results have started to show up in livestock production. One reason why agriculture is behind medicine is funding. The $17 million available to non-land-grant as well as to land-grant schools in the USDA's competitive grants programs in 1983 is very small compared to the $3 billion budget of the National Institute of Health (NIH) for biomedically oriented research grants. In addition, the National Science Foundation (NSF) and the NIH made more than $150 million available to students in non-agricultural related scientific disciplines whiles the USDA was granted, by Congress, only $5 million

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[2] Bremermann, H. *Theory of Catastrophic Diseases of Cultivated Plants* Journal of Theor. Biol. (1983), Vol 100

for fellowships or traineeships in agricultural science. There are indications that funding will increase in the future to boost research (Budlansky)

2.3 The Lag Structure of Research Impacts

2.3.1 Conceptual Issues

As noted earlier, the issue of maintenance research is not unrelated to the lag structure of the impact of agricultural research on output. There are three major factors affecting the temporal distribution of agricultural research impacts. First, there are administrative, operational and reporting lags between research expenditure and research output. Second, there is a lag between the production of research output and its adoption by users, with some users adopting research results more rapidly than others. Finally, there is depreciation of research output (Swallow et al.).

There are lags involved in the search for new knowledge. This follows from the fact that research takes time and increments in knowledge generated by research are a function of past as well as current research. For example, the initial sexual cross in the production of the currently successful wheat cultivar Avalon was made in 1969, but the variety was only ready to be released in 1980 (Miflin and Lea). Research efforts spent in any particular year may bear fruits in that year and subsequent years. This creates a systematic relationship (a lag form) between efforts spent (research expenditures) and knowledge increments (research output). This view has been expressed by Evenson (1968) and Griliches (1979).

Traditional theory of competitive markets assumes that information is costless and thus fully and equally available to everyone. However, there is a time element in the diffusion of the research output. Those closer to the source are likely to obtain the information quicker than others. Also, those who are less risk averse will adopt the research results more rapidly than those who are more risk averse (Anderson, Dillon and Hardaker).

Research output does depreciate in the real sense. Research depreciates for two reasons, obsolescence and deterioration. Research information is termed obsolete if it is replaced by better information for the same set of base conditions (Swallow et al.). This refers to the replacement of old inputs by superior or improved inputs. A certain amount of current research activity will confer a degree of obsolescence on the corpus of prior research findings (Pardey). There is deterioration in research information when changes in the base conditions render the information less productive. The output enhancing effects of previous research findings can be eroded by diseases, plant varietal deterioration, evolution of pests and pathogens, and other factors. This depreciation is real and is likely to be relatively important in the production of agricultural products.

The distinction between obsolescence and deterioration is that the development of an improved input has built on the knowledge associated with the old input in the obsolescence case. This is a natural process since almost all inputs eventually are replaced by superior inputs (Evenson (1968)). The obsolescence part of depreciation reinforces deterioration so that we expect a declining research impact perhaps after an initial period of increasing impacts when increases in adoption outweigh research depreciation. The relevance to maintenance research is that maintenance research replaces deteriorating research output.

2.4 Review of Previous Empirical Studies of Maintenance Research and of Lagged Research Impacts

"If the research effort required to maintain productivity is a positive function of the productivity level, it seems apparent that maintenance research will rise as a share of the research budget..." (Ruttan). Attempts have been made to evaluate agricultural research (efficiency, allocation, returns to investment) using several approaches, particularly consumer-producer surplus and production function analysis. Frequently, these attempts measure the additional research benefits resulting from added reseach dollars without considering the productivity declines that would have resulted without the research (Swallow et al.). If the share of maintenance research is rising in the budget, then failure to estimate or include it will result in an under-estimation of research benefits.

There has been very little work designed to measure the importance of maintenance research even though scientists recognize that research output depreciates over time. One of the few empirical analyses of maintenance research is a recent paper by Heim and Blakeslee. A low-order Almon polynomial (this procedure is evaluated later) was estimated with a lag length of seven years. The results were used to estimate the fraction of each year's research expenditures that were required to maintain wheat yield at the previous year's level and that which contributed to yield increases. Maintenance research is derived from an equation of the form:

$$E(Y_t|M, W, A_{t,}R^{m}_{t,}R_{t-1}, R_{t-2}, \dots) = E(Y_{t-1}|M, W, A_{t-1}, R_{t-1}, R_{t-2}, R_{t-3}) \qquad 2-1$$

where

Y_t is Washington wheat yield (all wheat),

M is average moisture stress,

W is average winterkill,

A_t is harvested average (all wheat), and

$R_{t-1} \dots R_{t-3}$ is lagged research expenditures including all production oriented state and federal outlays for wheat research in Washington deflated by the implicit GNP deflator (1972 = 100).

R_t^m is the research expenditure that would have maintained year t expected yield at year t-1 expected yield. Maintenance research as a fraction of the total research was calculated as R_t^m / R_t and 1 - R_t^m / R_t measures the fraction contributing to the yield increase.

The equation indicates that to obtain the previous year's level of output, maintenance research is needed given average weather conditions and lagged research expenditures. Their results indicate that well over 70 percent of public expenditures on production-oriented research for wheat was required for yield maintenance. They pointed out that "because of the high rate of biological adaptation, any significant prolonged reduction in research expenditures without compensation elsewhere would quickly result in an actual decline in wheat yields, not merely a levelling off in an otherwise positive yield trend." (Heim and Blakeslee). They go further to suggest that expenditures needed to maintain productivity in some sectors of U. S. agriculture may be substantial.

The procedure used to estimate maintenance research is subject to many deficiencies. The assumption made by Heim and Blakeslee is that maintenance research is solely responsible for changes in yield. This is not necessarily the case since yield-increasing research is also conducted. Second, the results of the lag model to estimate maintenance research are affected by econometric problems experienced in the estimation of the production function. They point out their dissatisfaction with the treatment of conventional inputs and "spillover" effects of research done elsewhere as well as the role of private sector research.

Their results indicate that the percentage of total research expenditures devoted to maintenance research was more than 60 percent for every year between 1959 and 1984. It was 98.7 percent in 1972. Even though breeders may be approaching wheat's theoretical biological limit to produce more grain (Austin et al.), the percentages assigned by Heim and Blakeslee appear high and warrant further investigation.

Another empirical estimation of maintenance research was conducted by Swallow et al. One approach used in the study incorporated quantitative genetics principles. The procedure was to measure the gap between theoretical and actual genetic progress. This gap is attributable to a number of factors but they argued that maintenance research is a significant one. Their results support the hypothesis that actual yield increases were less than theoretical increases but they are not conclusive. However, they indicate that a large part of the difference is likely to be attributable to the maintenance component of the research program. The focus of the paper was to examine the evidence that maintenance research exists in Virginia soybean production. The results from their regression analysis indicate virtually no deterioration of research embodied in the soybean varieties in Virginia. This means that base conditions changed very little, consequently there was little maintenance research. They point out, however, that it is possible that the time series of yield data was not sufficiently long to capture deterioration.

There has been an increase in disagreement over the temporal distribution of agricultural research output. Evenson (1983) points out "We have now achieved a consensus of perspectives on the general productivity and effectiveness of agricultural research programs." However, there has not been a consensus on the time distribution of agricultural research impacts. The failure to achieve consensus on the time distributional aspects of agricultural research stems from the conflicting evidence on the importance and timing of research depreciation.

Most of the empirical research evaluation studies have included a research lag but have appealed to previous research particularly to the work by Evenson (1968). For the length and shape of the lag, Evenson estimated two lag forms (detailed discussion of lag forms is presented in the next chapter). The first was a simple Jorgenson rational lag structure but his results did not meet his hypothesized lag shape so it was rejected. He proceeded to estimate a variety of national and regional lag relationships by imposing a De Leeuw inverted-V lag structure on the data. Many studies Bredahl and Peterson, Davis, Hastings, White and Havlicek, Smith et al., Swallow et al., Heim and Blakeslee, and Huffman and Evenson have used this procedure; using a variety of finite lag structures including the inverted-V, low-order (first and second) Almon polynomial, and other lag distributions.

Cline and Lu used a polynomial distribution lag with lag lengths varying from 7 to 17 years to estimate an aggregate production function for U.S. agriculture. The degree of polynomial was varied from two to four, and models with and without end-points constraints were estimated. Multicollinearity was a problem in the estimation process, but they found that the 13 year second-degree polynomial fit best and could not reject the fixed end-point assumption based on an F-test.

Bredahl and Peterson used a Cobb Douglas function to estimate the productivity and allocation of research in U.S. agricultural experiment stations. They calculated an internal rate of return by assuming 5, 6, 6, and 7 year inverted-V distributed lags for cash-grains, poultry, dairy, and livestock respectively. They pointed out that with a Cobb-Douglas function, if research expenditures increase proportionately across states over time, the length and shape of the lag will not affect the estimated research variable coefficient. Using a Cobb-Douglas production function, Davis compared the results of current research expenditures, expenditures lagged six years, and expenditures lagged over fourteen years in a second-order polynomial with end-point constraints. He could not reject the closed end-point assumption. White and Havlicek also used a closed end-point lag structure with a second-order polynomial in their analysis of research and extension impacts in U.S. agriculture. Smith, Norton, and Havlicek used this procedure to examine research impacts on several commodity groups by including research expenditures in closed end-point 12-year quadratic lags in production and value-added functions. However, the first end-point on each research lag was restricted to zero but the final end-point was left open so as not to predetermine the beginning and magnitude of research depreciation.

Swallow et al. lagged research expenditures 12 years and estimated an aggregate production function for U.S. cash grains. The final end-point of their cubic polynomial lag was left open. However, multicollinearity rendered their initial ordinary least squares results meaningless and ridge-regression was employed in an attempt to minimize the problem. The third-order (cubic) polynomial lag was used to accomodate the possibility of an increasing rate of impact of research. There was not an appreciable difference between the second-order and the third-order polynomial lags in the individual or the sum of the coefficients of the research variable. However, it appeared that research benefits continue to increase up to year 12 and at an increasing rate. The same procedure was used to estimate poultry production functions. Similar conclusions to that of cash-grains were reached and the results indicated that "Previous studies which imposed a closed end-point 12 - 14 years quadratic lag have forced depreciation to occur in their models sooner than it does in the aggregate, at least for U.S. cash-grains. These studies probably have overestimated research impacts during the first 6 years and underestimated impacts during the second 6 years. Total impacts, however, as measured by the sum of research coefficients for individual years may not be greatly distorted."[3] Swallow et al. lacked sufficient data to test the full length and shape of the research lag structure.

Heim and Blakeslee used a supply function approach to estimate wheat yields in Washington state. Research expenditures were lagged seven years and end-point constraints with a low-order Almon polynomial were employed in the estimation. A first-degree polynomial was chosen over a second-order degree polynomial based on minimum standard error of estimate subject to the requirement that results be economically meaningful. There is no indication as to how this constraint was imposed. They estimated that Almon weights begin at a positive level and decline monotonically. Most of the research impact, 79 percent, was experienced in the first four years. They point out that these impacts indicate that adoption of new knowledge is quite rapid.

Huffman and Evenson used the profit function (detailed discussion is in next chapter) approach to estimate supply and demand functions for multi-product U.S. cash grains farms. Agricultural research was constructed as the weighted sum of expenditures over previous years on applied crop, applied livestock, and basic research in public sector agricultural experiment stations. The research variable is lagged for 27 years but there is no mention of the lag structure in the paper. However, they indicate that the marginal effect of time on the shadow value of agricultural research is positive but diminishing. This study is of major interest to the current study because it used the profit

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[3] Swallow, B., Norton G., Brumback T., and Buss G., *Agricultural Research Depreciation and the Importance of Maintenance Research* A.E 56 Agricultural Economics, Virginia Polytechnic Institute and State University, Nov. 1985.

function approach. This approach facilitates the use of flexible functional forms in an analysis, disaggregated by commodity, the measuremant of the impacts of agricultural research on output.

Most previous studies have hypothesized an increasing and then a decreasing effect of research on output, supporting the hypothesis that research depreciates over time. However, there is conflicting evidence on the importance and timing of research depreciation. For example, Cline and Lu had a total of 17 years (maximum), Davis used six years, Smith, Norton and Havlicek, and Swallow et al. used 12 years. Huffman and Evenson used 27 lagged years and in an earlier work, Evenson (1978) used 26 years. Of critical importance is when depreciation (in other words when research output starts to decline) sets in or at least begins to offset the increasing impact of research due to increasing adoption of research results. Results from Evenson's 1978 study indicated that research depreciation did not begin until the 12th (for the southern states) or the 15th (for the northern and western states) years; other studies estimated it to begin in the 6th and 7th years. Of course, the differences might be explained by differences in commodities or time periods analyzed, but the differences are as large as to suggest measurement problems in at least some of the studies.

Another criticism of previous studies is the use of end-point constraints. Unless research output is made completely obsolete, its impact is not likely to depreciate to zero very rapidly. In fact, Evenson (1968) points out that "the true weights in the lag function do not decline to zero after 11 - 14 years but remain positive. In other words, some part of the research effects on the level of production neither depreciate in the real sense or is made obsolete by rediscovery."[4] Even if the tightly constrained inverted-V or quadratic Almon lag structure does not seem to be an unreasonable form for the lags involved in agricultural research, the final end-point constraints appear to be unreasonable. Several previous studies have alluded to the fact that research output does not depreciate to zero but because of multicollinearity they have used end-point constraints. The efforts made by Swallow et al. to control multicollinearity makes their study of particular interest to this thesis.

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[4] Evenson, R. *The Contribution of Agricultural Research and Extention to Agricultural Production* Ph.D. Dissertation 1968, University of Chicago (p. 42-43).

The use of end-point constraints have also been criticized on statistical grounds. Trivedi and Pegan argue that even if the imposed lag length is correct, assuming a polynomial order lower than the true order will always result in a biased polynomial distributed lag estimator. This suggests that if the "true" lag structure follows a sigmoid type distribution as Evenson (1968) hypothesized, then a third rather than a second-order polynomial seems a more plausible prior lag structure. Most of the studies using polynomial lags have not tested the appropriateness of the second-order assumption. Judge et al. provide methods for testing either the polynomial degree, the lag length, or both simultaneously. But the estimates generated by these procedures unfortunately have sampling distributions and properties that are unknown as a result of these complicated pretesting schemes.

One other criticism is that these lagging procedures are sensitive to the values obtained for the partial research production coefficients, and in particular the values obtained for the early years in the lag distribution. Consequently, constraining the lag distribution to the class of (exact) second-order polynomials or inverted-V structures may have conferred serious misspecification bias on the estimated lag weights. In particular, the implicit symmetry and smoothness assumptions place restrictions on the nature of the lag relationship which do not seem warranted on the basis of the available prior information (Pardey).

2.5 Summary of Chapter

The conceptual issues on maintenance research and the lag involved in agricultural research were presented in this chapter. Examples of maintenance research in the United States and other parts of the world were also presented. Review of previous empirical studies on maintenance research and of lagged research impacts indicated that little work has been done on maintenance research and that the procedures used to estimate the lag in agricultural research have met a number of criticisms. Despite all these criticisms researchers still have several options for estimating the lagged impact of research on output. These options are discussed in the next chapter.

The real world is usually the starting point. A particular problem, or merely a desire to understand, motivates one to move from the complicated world of reality into the domain of logical simplicity. By means of theoretical abstraction, one hopefully reduces the complexities of the real world to manageable proportions. The result is a logical model presumably suited to explain the phenomena observed. By logical argument (i.e., deduction) one then arrives at logical or model conclusions. However, these must be transformed, by means of theoretical interpretation, into conclusions about the real world.

C.E. Ferguson, *Microeconomic Theory* Richard D. Irwin Inc., 1972, (p. 5).

Chapter 3

METHODS

3.1 Introduction

Two primary methods are used in this dissertation to assess the magnitude and importance of agricultural maintenance research in the United States. The first method is to obtain the opinions of a broad range of scientists on the subject of maintenance research by sending a questionnaire to researchers at the state agricultural experiment stations. This chapter describes that questionnaire and the statistical procedure used to analyze the resulting data. The second method is to econometrically measure the time distribution of the impact of U.S. agricultural research in an attempt to capture the importance of research depreciation. The econometric method is described in this chapter and a detailed presentation is made of the sources and transformations of the data used in the model.

3.2 Scientist Questionnaire

Scientists often allude to the existence and importance of maintenance research. For example, Peterson and Fitzharris point out that much of the work conducted in the early years at the Minnesota Agricultural Experiment Station was maintenance work, or "applied-developmental" research and that this was closely associated with basic research on crops and livestock for the first forty years. Maintenance research proved to be very useful and probably prevented any appreciable decline in productivity owing to crop and animal diseases. Dalrymple stresses that since maintenance research may become increasingly important as agriculture becomes more complex, it is vital that further attention be given to its measurement.

The key objective of this study is to measure the magnitude and importance of maintenance research. As noted above, one of the methods for doing this is to seek information directly from researchers by sending questionnaires to scientists at state agricultural experiment stations. Some of the issues described in the previous chapter are used as a guide for questions to be included on the questionnaire.

The examples of maintenance research given in chapter 2 indicate that research depreciation calls for different types of research, that the length of time for solving various problems differs, and that costs involved in salvaging declining agricultural productivity might be considerably different across commodities. For example, while the stagnation of Hawaiian sugarcane production lasted for a long time (13 years), the replacement of corn varieties following the corn blight in 1970 took a relatively short period of time. Wheat varieties are systematically replaced by new varieties very rapidly, while soybean varieties tend to be planted for several years. Because of this, the questionnaire is structured to obtain information on the types of research conducted and the proportion of total research effort devoted to maintenance.

Agricultural experiment stations in the United States are organized on a state basis. Since there are geographical differences between states and also different commodities in different states, it is appropriate that the information on maintenance research on various commodities be obtained from each state. In the questionnaire, maintenance research is defined as the research effort needed to prevent agricultural productivity from declining. Examples of maintenance research are given in a cover letter attached to the questionnaire (See Appendix 1). The questions ask for examples of maintenance research in the scientists′ field, when research depreciation occurred, the types of research needed to affect the depreciation, and how long the research took. Responses to these questions are used to assess the scientists understanding of how maintenance research is defined, to describe the different types of maintenance research undertaken by the scientists for various crops and livestock, and to ascertain if maintenance research differ by commodity. The scientists are asked how much their research operating budgets are and the percentage of their efforts that they devote to maintenance research. This information is used to obtain information on the cost and/or time spent on maintenance research in relation to total research.

Two pre-tests of agricultural scientists on the campus of Virginia Polytechnic Institute and State University were conducted before the questionnaire was mailed to scientists throughout the United States. In the first test, maintenance research was defined and the first three examples of maintenance research were included in the cover letter. Respondents were asked to comment and make suggestions on the definition and the examples given. The comments and suggestions led to clarification of the definition of maintenance research to say that maintenance research has been referred to as ″productive″ research, ″productivity sustaining″ research, and ″defense-of-gains″ research. In addition, an animal scientist contributed the fourth example of maintenance research eventually used in the cover letter. Eight out of ten scientists in the test responded to the questionnaire.

A second pre-test was conducted with the clarified definition of maintenance research and the fourth example was included in the cover letter. The sample was different from the first pre-test. This was done to determine if other scientists would understand the definition and the examples of maintenance research and be able to respond with minimum difficulty. Seven out of eight agricultural scientists responded with little or no difficulty within one week. The other three did not respond. The questionnaire was mailed to all production-oriented agricultural scientists in the United States. The list of scientists and their location was obtained from the United States Department of Agriculture. Based on the response from the second pre-test, scientists were given two weeks to respond to the questionnaire. A follow-up letter was sent to those who did not respond after the two weeks.

The analyses of the information on maintenance research gathered in the questionnaire are quite simple. A general descriptive analysis of the types of maintenance research and the amount of funds spent on maintenance in each state are presented. This provides a broad representative picture of maintenance research by commodity and for all commodities in the United States. The mean of the responses to each question with a quantitative response is calculated. Comparing the means across commodities and across states highlights differences among commodities and also among states on the funds and time spent on maintenance research. At the national level, significant differences in the percentage of research effort devoted to maintenance research, by commodity, are assessed using t-tests (Scheffe's multiple-comparison procedure). Significant differences across commodities are then used to develop hypotheses about differences by commodity in research. These hypotheses are tested following estimation of the econometric model.

3.3 Model to Measure Research Lag

Research efforts are expected to have positive impacts on agricultural productivity through improvements in quality of inputs and through effects not embodied in inputs. It was pointed out earlier that research efforts generate new knowledge or information and that there is a lag in the search for new knowledge. It was also noted that there is a time element in the diffusion of research output. Public extension activities may shorten the time element in the diffusion of research output.

It was argued that knowledge or information generated by research efforts deteriorates and becomes obsolete. The effects of these two factors, particularly deterioration, is that the impact of research on agricultural productivity is reduced over time. When increments in deterioration and obsolescence outweigh the increments in knowledge, the impact of research on agricultural productivity declines in absolute terms.

The essential point is that to trace out the impact of reseach on agricultural productivity, one must bear in mind that there are lags between the expenditure of funds for research and the generation of new knowledge, and an adoption lag which reflects the lag between the development of knowledge and its use in actual production. These two lags have increasing and positive effects. A third set of factors - obsolescence and deterioration - reduces or slows down the impact of research on agricultural productivity. The convolution of these three lags generates a distributed lag structure which rises, reaches a maximum, and then declines. Theoretically, we might expect the impact of research to increase at an increasing rate initially, then at a decreasing rate, to reach a maximum, and then decline (Figure 1).

The procedures which can be used to estimate this lag are discussed below. Ignoring other inputs for the moment, an equation designed to explain research induced variations over time in the mean value of agricultural output can be represented by:

$$Y_t = \alpha + \beta X + \varepsilon_t \qquad 3.1$$

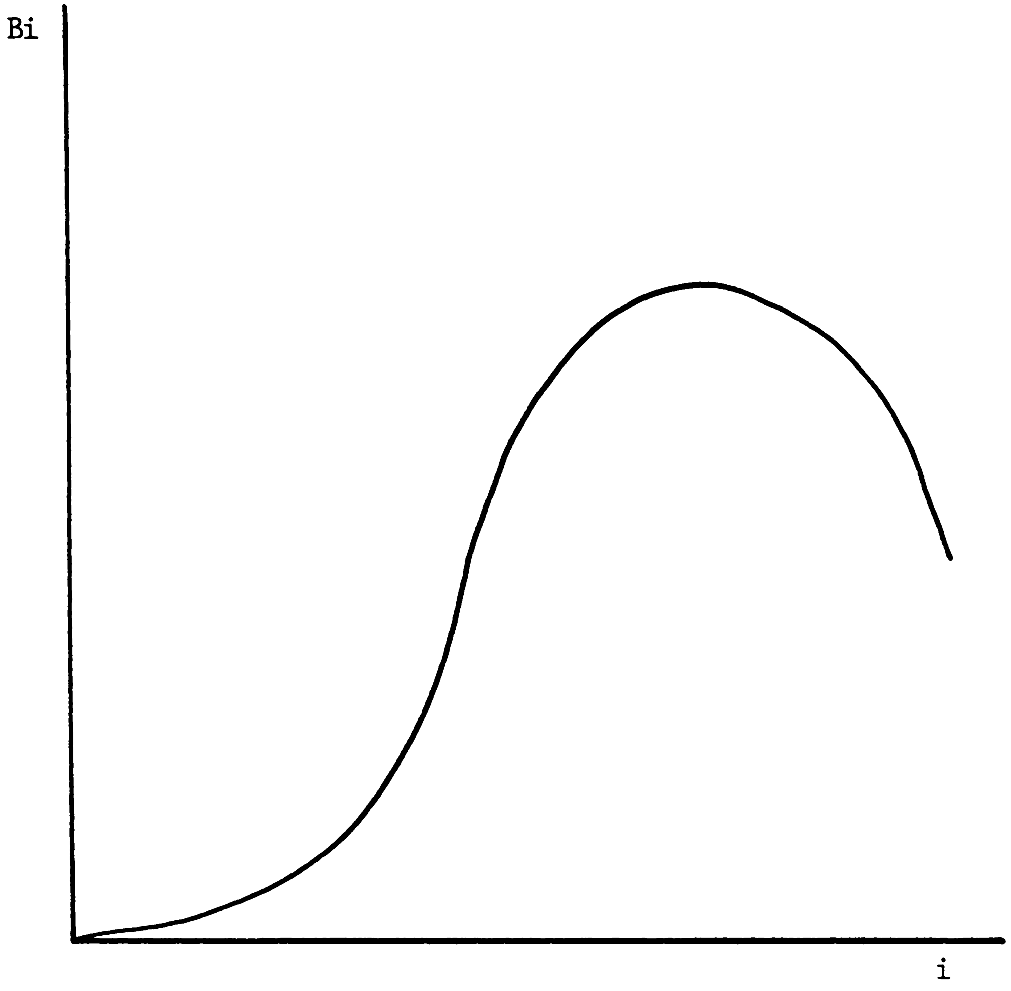
where Y_t is the dependent variable (output),

X is a vector of lagged values of the independent variable (research),

ε_t is the error term, and

α and β are parameters to be estimated.

This formulation assumes that current value of Y depends on current values of X and on past values of X. Writing X in its expanded form:



where: Bi is the impact of research on agricultural productivity
i is time

Figure 1. The Impact of Research on Agricultural Productivity

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \cdots + \beta_m X_{t-m} + \varepsilon_t \qquad 3.2$$

where Y_t and ε_t are as defined above,

X_t ... X_{t-m} are the lagged research variables, and

β_0, β_1, ... β_m are the unknown coefficients or weights.

Theoretically, equation 3.2 can be estimated; however, because of a potential degrees of freedom problem (if m is large, there may not be enough observations to estimate the parameters) and the likelihood of severe multicollinearity, a distributed lag is usually formulated by placing some restrictions on the regression coefficients (β_0 ... β_m) to estimate the equation. This reduces the number of variables in the equation and hence the number of coefficients to be estimated. Some of the distributed lags used in previous research evaluation studies are discussed briefly below.

Evenson (1968) used the inverted-V distributed lag to capture the lagged impact of agricultural research. This lag structure is characterized by the lag weights satisfying:

$$\beta_i = c + di \qquad i \leq \frac{n}{2} \qquad 3.3$$

$$\beta_i = e - fi \qquad i \geq \frac{n}{2} \qquad 3.4$$

where c and e are the intercepts, d is the change in β_i (research impact) relative to a one unit change in i (time) when β_i is rising, and f is the change in β_i (research impact) relative to a one unit change in i (time) when β_i is declining.

This imposes a specific form on the weight distribution function (linearly increasing and declining impacts). This is a very crude approximation to the hypothesized shape of the research impacts on agricultural production because it does not allow for non-linear impacts.

Heim and Blakeslee, and Blakeslee used the geometric lag to estimate the impacts of agricultural research. The geometric lag assumes that the lag effects in equation 3.2 declines or increases geometrically. The lag weights satisfy,

$$\beta_i = gw^i \qquad i = 0,1, \ldots \qquad 3.5$$

$$0<w<1$$

where g is the intercept, and w^i are the weights to be estimated.

Heim and Blakeslee assumed that the weights are high initially and then decline. It is hypothesized in this study that the impact of agricultural research on agricultural productivity first increases and then declines. Consequently, the geometric lag is inconsistent with our hypothesized lag shape.

The next two distributed lags described below do allow for shapes which are consistent with our hypothesized shape.

Polynomial distributed lag: The polynomial distributed lag was developed by Almon (1965). The shape of the Almon lag is flexible to allow for different shapes so that one could use it to incorporate increasing and decreasing rates of research impacts on agricultural productivity. Given equation 3.2, the distributed lag can be specified as:

$$\beta_i = \alpha_0 + \alpha_1 i^1 + \alpha_2 i^2 + \alpha_3 i^3 + \cdots + \alpha_q i^q. \qquad 3.6$$

With this lag, the β's are assumed unknown but they can be approximated arbitrarily well on a closed interval by a polynomial function of a sufficiently high degree. Thus, it is assumed that the lag weights are captured by a polynomial of degree q (Judge et al.). For example, a third-order (q = 3) polynomial could be used to capture the increasing and then decreasing research impacts hypothesized above. Many research evaluation studies have incorporated symmetric second-order research lags in their econometric functions but this too is inconsistent with the shape of the research lag hypothesized in this study. Incorporating a third-order distributed lag in a regression equation (3.2) gives:

$$Y_t = \alpha_0 \sum_{i=0}^{n} i^0 X_{t-i} + \alpha_1 \sum_{i=0}^{n} i^1 X_{t-i} + \alpha_2 \sum_{i=0}^{n} i^2 X_{t-i} + \alpha_3 \sum_{i=0}^{n} i^3 X_{t-i} \qquad 3.7$$

where Y_t is output,

X_{t-i} is the lagged research variable, and

α_0 ... α_3 are the weights.

Equation 3.7 can be rewritten as:

$$Y_t = \alpha_0 Z_{0t} + \alpha_1 Z_{1t} + \alpha_2 Z_{2t} + \alpha_3 Z_{3t}. \qquad 3.8$$

where Y_t is as defined above and,

$$Z_{0t} = \sum_{i=0}^{n} i^0 X_{t-i}$$

$$Z_{1t} = \sum_{i=0}^{n} i^1 X_{t-i}$$

$$Z_{2t} = \sum_{i=0}^{n} i^2 X_{t-i}$$

$$Z_{3t} = \sum_{i=0}^{n} i^3 X_{t-i}$$

Y_t can be regressed on Z_{0t}, Z_{1t}, Z_{2t} and Z_{3t}. The estimates of the α's can then be used to obtain the β's using the equation :

$$\beta_i = \alpha_0 + \alpha_1 i^1 + \alpha_2 i^2 + \alpha_3 i^3. \qquad 3.9$$

Therefore,

$$\beta_0 = \alpha_0, \qquad 3.10$$

$$\beta_1 = \alpha_0 + \alpha_1(1) + \alpha_2(1) + \alpha_3(1) \qquad 3.11$$

$$\beta_2 = \alpha_0 + \alpha_1(2) + \alpha_2(2)^2 + \alpha_3(2)^3 \qquad 3.12$$

$$\beta_3 = \alpha_0 + \alpha_1(3) + \alpha_2(3)^2 + \alpha_3(3)^3 \qquad 3.13$$

$$\beta_n = \alpha_0 + \alpha_1(n) + \alpha_2(n)^2 + \alpha_3(n)^3 \qquad 3.14$$

It can be argued that it is reasonable for the beginning end-point of the lag to be constrained to zero, $\beta_{-1} = 0$, because there are no research impacts before the research is conducted. However, the terminal end-point is left open or alternative end-points tested.

The long-run response is the sum of the weights, $\Sigma\, \beta_i$, and the average or mean lag is, $\Sigma\, i\, \beta_i \,/\, \Sigma\, \beta_i$, where i is the length of the lag. The long-run response is important because it indicates the percentage change in output given a one percent change in research. The maximum or mean point of the total lag indicates the beginning of the decline of research impacts on agricultural productivity. In other words, the increments in obsolescence and deterioration begin to outweigh the increments in knowledge. This point illustrates why maintenance research is necessary to sustain productivity levels. The mean lag indicates the average time period for a unit change in research to be transferred to output. Estimation of the total shape of the research lag is a main focus of this study.

The "Rational" Lag: The rational lag was developed by Jorgenson out of the Pascal distributed lag described by Solow (1960):

$$Y_t = \frac{\alpha(1-w)^r}{(1-wL)^r} X_t + \varepsilon_t. \qquad 3.15$$

The denominator, $(1\text{-}wL)^r$, is a polynomial function in the lag operator, L. The numerator is a zero-order polynomial function in the lag operator, L.

Jorgenson proposed the general rational lag structure:

$$Y_t = \frac{U(L)}{V(L)} X_t + \varepsilon_t. \qquad 3.16$$

where Y_t is output, and X_t is the research variable.

U(L) and V(L) are polynomials in the lag operator of the order m and n respectively. He proved that any arbitrary lag function can be approximated to any desired degree of accuracy by a rational distributed lag function with sufficiently high values of m and n (Judge). However, Griliches (1967) pointed out that a higher degree order polynomial for V(L) will seldom generate a lag distribution different from that of the Pascal distribution, hence in practice the polynomial used is of order two or three. The third-order polynomial is explored in this thesis and would be specified as:

$$Y_t = \frac{u}{1 - bL - cL^2 - dL^3} X_t. \qquad 3.17$$

The equation to be estimated is:

$$Y_t = uX_t + bY_{t-1} + cY_{t-2} + dY_{t-3}. \qquad 3.18$$

This lag structure admits a variety of possible lag shapes without any restrictions allowing the data to "speak" for themselves and capture the true nature of the lag involved. Unfortunately, the data for this study is for two agricultural years and thus does not allow using the rational lag beyond one period, which generates a linear shape. Since a linear shape of the impact of research on agricultural productivity does not support the hypothesized shape, the rational lag is not employed in this study.

The weights of the third-order Almon lag is estimated by embedding the distributed lag in an econometric model. The model is a profit function model estimated for the U.S agricultural sector disaggregated by commodity groups. The reason for disaggregation is the hypothesis that the importance of maintenance research differs by commodity. The profit function is discussed in the next section.

3.4 The Profit Function

Ruttan's summary of agricultural research productivity studies indicates that calculation of consumer-producer surplus and production function estimation are the two most common approaches used to estimate the contribution of research to agricultural productivity. As noted in chapter 2, another approach has been used by Huffman and Evenson - the profit function approach. This study also will employ that approach and the rationale is discussed below.

There are several advantages in using the profit function approach. First, it allows for the use of flexible functional forms (an equation that is a second-order Taylor's approximation to any arbitrary functional form is termed flexible (Diewert). Second, input demand equations, output supply equations, and the shadow value equations can be derived from the profit function directly. This facilitates the estimation of important economic magnitudes - own price, cross price, and output supply elasticities and the marginal products of the fixed factors.

Another advantage of this approach is that only normalized prices and fixed factors are included in the normalized profit function and these are normally considered to be exogenously determined if firm level data are used. Thus simultaneous equations bias is avoided. In production function estimation, the right hand side may include both dependent and independent variables since variable inputs such as fertilizers may be jointly determined with farm output. In general, the profit function is assumed to be twice continuously differentiable, convex, and monotonic in prices and fixed inputs.

The profit function relates maximized variable profits to the prices of outputs and inputs and to the quantities of fixed factors. Using two outputs, two inputs and one fixed factor, the profit function can be specified as:

$$\pi = \pi(P_{e1}, P_{e2}, P_1, P_2, Z), \qquad 3.18$$

where π is the maximized profits,

P_{e1} and P_{e2} are the output prices,

P_1 and P_2 are the input prices, and

Z are the fixed (exogenous) factors, for example research.

The function can be normalized by dividing the other prices by one of the output or input prices. This reduces the number of variables by one and provides a profit function which is homogeneous of degree one in all prices.

The usefulness of the normalized profit function arises out of the application of Hotelling's lemma. Applying Hotelling's lemma, the system of (profit maximizing) output supply and input demand functions can be obtained by differentiating the normalized profit function with respect to prices:

$$-\frac{\partial \pi^*}{\partial P_1} = X_i^*(P_{e2}', P_1', P_2', Z) \qquad i = 1,2 \qquad 3.19$$

$$\frac{\partial \pi^*}{\partial P_{e2}} = Y_i^*(P_{e2}', P_1', P_2', Z) \qquad i = 1,2 \tag{3.20}$$

where π^* is the normalized profit,

X_i^* are the optimal input quantities,

Y_i^* are the optimal output quantities,

$P_{e2'}$ is the normalized output price,

P_1prime is the normalized price of input 1,

P_2prime is the normalized price of input 2, and

Z is the fixed factor.

Equation 3.19 indicates that the negative of the first derivative of the normalized profit function with respect to the normalized or relative input price is the optimal input quantity or the factor demand curve. The first derivative of the normalized profit function with respect to normalized output price is the optimal output quantity or the output supply equation, equation 3.20.

The shadow value equations of the fixed factors can also be obtained from the normalized profit function. The shadow value, represented as the total effect of the fixed factor, research, on profit is obtained by differentiating the normalized profit function with respect to Z (Diewert) :

$$\frac{\partial \pi^*}{\partial Z} = \gamma_i^*(P_{e2'}, P_{1'}, P_{2'}, Z) \tag{3.21}$$

where

γ_i^* are the shadow prices of the fixed factors.

The importance of this is that the shadow value is related to the marginal product of these factors:

$$\frac{\partial \pi^*}{\partial Z_i} = \frac{\partial Y^*}{\partial Z_i}. \tag{3.22}$$

This means that the marginal products of the fixed factors can be calculated from equation 3.20 or 3.21. The three duality relationships show that all important economic magnitudes can be estimated from the profit function. Hotelling's lemma provides factor elasticities and output supply elasticities which can be estimated from equations 3.19 and 3.20.

These derivations are useful because instead of solving a system of simultaneous equations as is the case with the production function approach, the factor demand curves are simply obtained as the first derivatives of the normalized profit function. This holds for any number of inputs and outputs. This is important because in this study, multiple outputs and inputs are used in an econometric model. There are other computational and statistical advantages of the profit function approach which are discussed below.

3.5 The Econometric Model

Three assumptions are employed in the formulation of the profit function:

a. firms are profit maximizing,

b. firms are price takers in both the output and input markets, and

c. the production function is concave in the variable inputs.[5]

The U.S. agricultural sector is more like the competitive model of economic theory than other industries. Therefore, the input and output markets of the agricultural sector are assumed to be competitive; implying that farms in all states are price takers in the input and output markets. Most researchers, using the profit function, also have made these assumptions. However, it must be recognized that using industry data with these assumptions can result in simultaneity problems. It is assumed also that the objective of farms in the United States agricultural sector is best described

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[5] Lau, L.J. and Yotopoulos, P.A. *"Profit, Supply and Factor Demand Functions"* American Journal of Agricultural Economics, Feb. 1972 p. 11-18.

by maximization of expected profit. Antonovitz and Roe, Dillon and Hardaker, Just, and Binswanger have documented that farmers exhibit risk-averseness. Gardner and Chavas, and Pope have shown that the same results could be consistent with profit maximization. For this study, the assumption of profit maximization is maintained. Most, if not all, U.S. farms are multiple-product firms and resource allocation decisions are joint. The profit function facilitates empirical analysis of multiple-product firms. It is more difficult estimate the effects of research on the separate products of a multiple-product firm when using production functions.

In order to specify the profit function in an econometric model, a decision has to be made on the form of the function. To obtain a reasonable set of output supply and input demand equations and to permit examination of technology without imposing arbitrary restrictions on choice, a flexible functional form for the profit function is sufficient (Fuss, McFadden, and Mundlak). Three functional forms have come to the forefront in recent years for use as a profit function: the normalized quadratic (Shumway; Lopez(1985); Huffman and Evenson); the generalized Leontief (Lopez (1980)) and the translog (Sidhu and Baanante; Ray; and Weaver).

The normalized quadratic profit function is employed in this study. This choice is made for a number of reasons. First, the normalized quadratic profit function can be viewed as a local second-order approximation because it is a Taylor series expansion to an arbitrary profit function. Second, the quadratic functional form maintains linear homogeneity of the profit function. This is imposed by normalization. In addition, because both the normalized profit and input requirement functions are quadratic, their respective Hessians are matrices of constants. The duality between the Hessian matrices of primal and dual problems permits the parameters of one to be derived from the other (Lau). The first derivatives of the quadratic function give output supply and input demand equations that are linear in normalized prices of outputs, variable inputs, and quantities of fixed inputs.

Combining the discussion on distributed lags, the profit function, and the functional form, the general econometric model for this study can be specified as:

$$\pi'^{*} = \beta_0 + \sum_{i=1}^{m-1} \beta_i p_{i'} + \sum_{i=m+1}^{n} \beta_i z_i + \frac{1}{2} \sum_{i=1}^{m-1} \sum_{j=1}^{m-1} \beta_{ij} p_{i'} p_{j'} + \sum_{i=m+1}^{n} \sum_{j=m+1}^{n} \beta_{ij} z_i z_j +$$

$$\sum_{i=1}^{m-1} \sum_{j=m+1}^{n} \beta_{ij} p_{i'} z_j \qquad 3.23$$

where π' is restricted profits (total revenue - total cost) normalized on output price p_m, z_i is the ith fixed factor, the output and variable-input prices are: $P = (p_1, \ldots, p_m)$, and the fixed factors (such as lagged research) quantities, $Z = (z_{m+1}, \ldots, z_n)$, and β_0, β_{ij} are parameters to be estimated.

As noted earlier, differentiating the quadratic profit function with respect to its arguments, p_1 to p_m gives a system of variable input demand functions and output supply functions respectively:

$$\frac{\partial \pi^{*}}{\partial p_{i'}} = x_i = \beta_i + \sum_{j=1}^{m-1} \beta_{ij} p_{j'} + \sum_{j=m+1}^{n} \beta_{ij} z_j + \varepsilon_t \qquad 3.24$$

where

x_i are the profit maximizing input or output levels (x_i are negative for inputs), and

ε_t is the error term.

The normalized profit function together with the input demand functions and the output supply functions are estimated jointly as a system. However, one of the functions is dropped to avoid linear dependency.

If the profit function is twice continuously differentiable, its second partial derivatives are invariant to order of differentiation. Since the output supply/input demand equations are by assumption the first derivatives of the profit function, their slopes are the second derivatives. To impose symmetry on the matrix of second derivatives, cross-equation restrictions are required for cross price terms. Most of the parameters of the equation that was dropped can be derived through the homogeneity and the symmetry restrictions imposed on the system. All the neoclassical restrictions (symmetry, homogeneity and separability conditions) are tested. Because the homogeneity condition cannot be tested for the normalized quadratic, the translog profit function will be used to test this condition. Analyses of the responses to the questionnaire and the econometric model are presented in the next chapter; a detailed description of data sources and construction of variables concludes this chapter.

3.6 The Data and Construction of Variables

3.6.1 Introduction

The data are for all major agricultural outputs and inputs in the United States for the years 1978 and 1982 derived from a number of sources. Data for earlier years are used for lagged variables. Data sources are provided with the description of each variable. The New England States (Connecticut, Maine, Massachussetts, New Hampshire, Rhode Island, and Vermont) are excluded from the analysis for reasons discussed below and the remaining forty-two states in the contiguous forty-eight states are included.

All variables (outputs and inputs) are measured on a per farm per state or a per state basis. In some cases, transformations are made to obtain consistent output quantities and prices. Where appropriate, weights and indexes are used to adjust for differences in input quantities and qualities. It was argued earlier that because of differences in maintenance research for various commodities, it is appropriate to disaggregate the data by commodity groups. The next section outlines the sources, transformations, and grouping of the data.

3.6.2 Output

The output variables are constructed from data on twenty nine commodities. The commodities are: corn, sorghum, wheat, oats, barley, rice, hay, sunflower, soybeans, sugarbeets, sugarcane, potatoes, cotton, tobacco, peanuts, vegetables, apples, grapes, peaches, oranges, grapefruits, cattle and calves, turkey, chickens, broilers, sheep, hogs, milk, and eggs. These commodities are grouped into foodgrains, feedgrains, other crops, hay, milk, poultry, and other livestock.

3.6.2.1 Foodgrains

Various studies have subdivided grains into feed grains and food grains or cash grains. Huffman and Evenson considered only cash grains which were composed of wheat, soybeans, and feed grains (corn, sorghum, oats, and barley). Smith, however, categorized corn, soybeans, wheat, oats, barley, rice, and sorghum as cash grains. Other studies, Norton, and Bredahl and Peterson, used the United States Department of Agriculture and/or United States Department of Commerce classification of cash grains in their analyses. This study adopts the USDA classification of combining wheat and rice as foodgrains.

3.6.2.2 Feedgrains

The commodities placed in this category are: corn, soybeans, oats, barley, and sorghum. The physical quantity of each commodity (Census of United States Agriculture, and Agricultural Statistics) represent the output. The sum of the quantities is the output of feedgrains. The quantity (bushels) of each commodity is multiplied by the price of the commodity (Agricultural Prices and Agricultural Statistics) to obtain the value of the commodity. The sum of the values represent the value of feedgrains. The price of feedgrains is obtained by dividing the value of feedgrains by the quantity of feedgrains.

3.6.2.3 Other Crops

This category consists of thirteen crops: sunflowers, sugarbeets, sugarcane, potatoes, cotton, tobacco, peanuts, vegetables, apples, peaches, grapes, oranges, and grapefruits. The output of each crop is represented by the quantity produced (Census of United States Agriculture, and Agricultural Statistics) in each state. The sum of the quantities represent the output of other crops. The physical quantity of each crop is multiplied by the price of the crop (Agricultural Prices, Outlook and Situations publications) to derive the value of the crop. The value of other crops is obtained by summing up the values of these crops. These commodities are grown in few of the states and their values are generally smaller than those of foodgrains. The price of other crops is derived by dividing the value of other crops by the quantity of other crops.

3.6.2.4 Hay

Hay is treated as a separate variable since it is produced in all the states. The output of hay is represented by the quantity produced (Census of United States Agriculture and Agricultural Statistics) in each state. The sum of the quantities represent the output of hay. The value of hay in each state is obtained by multiplying the quantity by the price. The sum of the values represent the value of of hay. The price of hay is derived by dividing the value of hay by the quantity of hay.

3.6.2.5 Poultry

The poultry commodities are: chickens, broilers, turkeys and eggs. The physical quantity produced (Census of United States Agriculture, and Agricultural Statistics) in each state is the output of each commodity. The sum of the quantities is the output of poultry. Some studies multiplied the sale of these commodities by an index of prices of each commodity to obtain the value of poultry. In this study, the value of each commodity is the quantity produced multiplied by the price. The sum of the values represent the value of poultry. The price of poultry is derived by dividing the value of poultry by the output of poultry.

3.6.2.6 Milk

The component of output on dairy farms was assumed to be homogeneous across geographical areas, hence the output measure is the physical quantity of milk produced (Census of United States Agriculture) in each state. The sum of the quantities of milk is the output of milk. The value of milk is the product of the quantity produced and the price. The sum of the values is the value of milk. The price of milk is obtained by dividing the value of milk by the quantity of milk.

3.6.2.7 Livestock other than Poultry and Dairy

This group of animals includes cattle and calves, sheep and lambs, and hogs and pigs. Bredahl and Peterson, and Smith argued that because of double counting, sales on farms of these animals could not be used as the output of livestock; rather, the value per head of each animal was multiplied by the number of animals sold.

In this study, the physical quantity produced of each type of livestock (Census of United States Agricuture 1978, 1982) represents the output. The sum of the quantities of livestock represents the output of livestock. The value of each livestock is the quantity multiplied by the price. The sum of these values is the total value of livestock. The price of livestock is obtained by dividing the total value by the total quantity.

3.6.3 Transformations of Output Quantities

It was mentioned in the introduction to this section that some transformations are made to the output data. This is necessary because the commodity data are measured in different units and it is necessary to have all of them in the same unit in order to group them. For example, corn is measured in bushels while rice is in hundredweights. All the commodities are measured in thousand pounds.

3.6.4 Output Prices

In most cases, output prices are obtained from Agricultural Statistics, Census of United States Agriculture, Outlook and Situation publications, and other sources. If a price variable cannot be obtained directly, the value given is divided by the quantity (output) to derive the output price.

Any profit function analysis must include expected output prices. Actual expectations are unknown and consequently numerous approaches have been developed and evaluated for inclusion in agricultural econometric models. These include adaptive expectations, rational expectations, and futures prices. Two of these approaches (adaptive expectations and futures prices) are used in this study for a number reasons. Historically, researchers have used either the previous year's prices (adaptive expectations) or some other weighted combination of past prices since these were the only prices available and it can be argued that farmers use them as decision making guides.

Other prices that farmers can observe when making decisions are futures prices. Futures market prices are used to formulate the expected output prices for two reasons. First, futures prices can be interpreted as expectations of subsequent spot prices. Second, as Kofi has pointed out, these prices reflect the future conditions of supply and demand insofar as the current information and market conditions permit.

A futures market price will differ from a cash market price at the time of delivery by approximately the cost of delivery. A term called the "cash basis" is the difference between the cash price in the state where the futures price is quoted and the cash price in the other states. Note that this definition of a basis is different from the normal definition which is the difference between cash and futures prices. The state differences in futures prices are adjusted by this basis to approximate the expected prices in each state. For example, the following calculations are made to obtain the price of corn in Virginia.

$$B_V = \frac{\sum_{i=1973}^{1977} (PC_{Vi} - PC_{Ii})}{5} \tag{3.25}$$

$$LFPC_V = B_V + FPC_{C,} \tag{3.26}$$

where B_V is the cash basis of corn in Virginia,

PC_{Vi} is the average cash price of corn in Virginia (Grain Market Weekly) in year i,

PC_{Ii} is the average cash price of corn in Illinois in year i,

FPC_C is the September futures price of corn in Chicago in May (The Wall Street Journal), and

$LFPC_V$ is the local futures price in Virginia.

Equation 3.25 is used to adjust for the cross-sectional differences between the average cash price of corn in the state where the futures price is quoted (Illinois) and the average cash price of corn in Virginia. Equation 3.26 is used to calculate the local futures price in Virginia. This is done for corn, soybeans, wheat, potatoes, cotton, oats, and barley.

3.6.5 Inputs

The variable inputs in this study are: fuel, labor, fertilizer, and feed.

3.6.5.1 Fuel

Expenditures on fuel are made up of expenditures on gasoline, gasohol, diesel fuel, liquid fuel, butane, propane and kerosene (Census of United States Agriculture 1978, 1982). The price of each type of fuel is obtained as the average of twelve monthly prices (Agricultural Prices Annual Summary). The quantity of each type of fuel is derived by dividing the expenditures on each type of fuel by their respective prices. The sum of the quantities of all types of fuel is used as the quantity of fuel. The price of fuel (all types together) was obtained as:

$$PF = \frac{VF}{QF} \tag{3.27}$$

where PF is the price of fuel, VF is the value of fuel, and QF is the quantity of fuel.

3.6.5.2 Labor

The labor variable used in this study was originally specified by Griliches. He measured it as the number of mandays worked on the farm. Studies by Davis, Bredahl and Peterson, Norton, and Smith also used mandays to measure the labor variable.

This study uses mandays of agricultural labor which are composed of three types: operator, hired, and contract labor. Using mandays assumes that agricultural labor is homogeneous across states. Mandays could have been adjusted by the state wage rate under the assumption that labor is mobile, and that wages serve as a quality indicator but this is not done here because we do not adopt the point of view that a higher wage is necessarily indicative of a higher quality of labor. One reason is that wages reflect differences in the cost of living. In other studies, labor is adjusted by education because of quality differences in managerial abilities attributable to education. Education (discussed below) is treated as a separate variable in this study.

The labor variable (Census of United States Agriculture 1978, 1982) is calculated as follows:

Operator Labor

$$L_0 = (N_1 + .6N_2)250 - L_1 \qquad 3.28$$

where: L_0 = mandays of operator on-farm labor,

N_1 = number of operators less than 65 years of age,

N_2 = number of operators greater than 65 years of age (Griliches, Evenson, Norton, and others used the concept that farming activities of farmers who are sixty-five years and over is sixty percent of those who are under sixty-five years old. This concept is adopted in this study; hence, N_2 is multiplied by .6), and

L_1 = mandays of operator off-farm labor.

Hired Labor

$$X = \frac{VHL}{WR} \qquad 3.29$$

$$L_H = \frac{X}{8} \qquad 3.30$$

where: VHL is the value of hired labor,

WR is the wage rate per hour,

X is the number of hours of hired labor, and

L_H is the mandays of hired labor.

Contract Labor

$$G = \frac{VCL}{WR} \tag{3.31}$$

$$L_C = \frac{G}{8} \tag{3.32}$$

where: VCL is the value of contract labor,

G is the number of hours of contract labor, and

L_C is the mandays of contract labor.

Total Labor

$$L_T = L_0 + L_H + L_C \tag{3.33}$$

where: L_T = total mandays of labor

It is assumed that labor works for 250 days out of the year and 8 hours a day. The total expenditure on labor is total mandays of labor (L_T) multiplied by the wage rate.

3.6.5.3 Fertilizer

Previous studies have measured fertilizer as the total expenditures on fertilizer or a weighted quantity of nutrients. The nutrient content reflects the proportion of applied fertilizer made up of elemental nitrogen, potash, and phosphrous. These nutrients have different effects on output. The relative prices of these nutrients have been used as weights to reflect the quality differences. However, Davis found significant differences in the weights used in previous studies. He constructed weights relative to a unit of nitrogen but found that this also exhibited considerable variability and therefore decided to use a range of possible weighting procedures. Norton, and Smith used the value of commercial fertilizer per farm in their models.

The quantity of commercial fertilizer (Census of United States Agriculture 1978, 1982) is used in this study and the price of fertilizer is obtained by dividing expenditures on fertilizer (Census of United States Agriculture 1978, 1982) by the quantity of fertilizer. The price is the independent variable in the econometric model.

3.6.5.4 Feed

Various categories of feed have been used in previous studies. The reason for categorizing feed is because of the possibility of double counting of feed purchased to be fed to livestock and the purchase of feeder livestock.

Davis pointed out the problem of double counting but did not make any adjustment for it. However, he considered four categories of feed: formula feed, feed ingredients, whole grains, and hay, green chop, and silage. Smith considered the last three of these components and made a rougher approximation of actual amounts fed than in previous studies. For this study, there are no attempts to categorize or to exclude intrastate sales from the data on feed. Therefore, there is a potential double counting problem with the data on feed. The expenditures on feed (Agricultural Statistics) are divided by the quantity of feed to obtain the price of feed. The price is the independent variable in the econometric model.

3.6.6 Profit

Since a profit function approach is used in this study, the variable profit generated in each state has to be obtained in order to estimate the model. All the components needed to calculate profit have been identified. Profit is derived as:

$$\Pi = V - E \qquad 3.34$$

where Π is the profit from agricultural production,

V is the sum of the value of all agricultural outputs, and

E is the sum of the expenditures on all variable inputs.

Profit is the dependent variable in the profit function.

3.6.7 Fixed Factors

The fixed factors that affect output/input choices are the land stock, rainfall, research, education, extension, and capital stock. Methods used in previous studies to measure these variables are mentioned, and those adopted in this study are discussed.

3.6.7.1 Land Stock

Simply using acreage of land as a measure of land stock in agriculture is inappropriate because of omission of any allowance for quality differences between states. The reported value of agricultural land reflects several factors other than quality differences. Davis pointed out that the most important of these are:

i) the value of land as an inflation hedge,
ii) changes in price certainty over the period as a result of government policies,
iii) technological advances, and
iv) increases in urban use alternatives.

Most studies have used a set of state land quality indexes to adjust for differences in the quality of land. The resultant unit of measure was the constant dollar value of a standard quality acre of land. This was the procedure used by Davis in his thesis. However, Peterson has argued that a land quality index based on raw land prices will be biased, which in turn will result in biased coefficients in a production function or its dual. The reason for this is that this measure assumes that cross-sectional differences in land prices are due entirely to differences in land quality as determined by agricultural uses. Should prices of agricultural land be influenced by non-agricultural uses, this measure of land will be biased. Peterson's results of estimating a reduced-form equation explaining differences in land prices suggest that nearly two-thirds of this variation is attributable to non-agricultural uses. He, therefore, constructed a cross-section land quality index which excluded the influence of nonagricultural uses. His index procedure is used in this study.

The land stock variable is measured as a price-weighted quantity index of three land types (irrigated land, harvested cropland, and pasture and grazing (Census of United States Agricuture 1978, 1982)):

$$L_S = L_u(M) - S \tag{3.35}$$

where L_s is the land stock,

L_u is the sum of the acreage of the three land uses,

M is the set of weights constructed by Peterson, and

S is the acreage set-aside

3.6.7.2 Rainfall

Several studies have included rainfall and temperature as weather variables. Davis categorized the weather variable into two effects, location and time. He used the subjective index of weather conditions published by the USDA in Crop Production. This is an index reflecting the subjective judgement of crop reporting officers as to the effect of weather on pasture. Several studies have used the weather index constructed by Stallings which used the residuals from the regression of crop yields on time. Other researchers (Nguyen and Barker, Omry, Shaw) have constructed variations of Stallings index and used them in their models. Other studies such as Smith, Norton, and Havlicek have chosen deviations from normal rainfall or temperature in particular months.

The rainfall variable adopted in this study is the deviation from normal July rainfall in each state. Considering the number of crops in this study it is difficult, if not impossible, to construct an appropriate weather variable since each crop requires different rainfall and temperature conditions. Davis pointed out that for individual crops, each with its individual growing season, data on rainfall and temperature would be needed for specific weeks or months. The problem of multicollinearity arises when this many variables are included in a model; therefore, Davis' suggestion is not adopted in constructing the rainfall variable. The reason for choosing July rainfall in this study is that rainfall in July is critical for the growth of several of the crops.

3.6.7.3 Research and Extension

These two variables have been specified in various forms in the literature. They have been included separately or combined as one variable in models used to assess their impacts on agricultural productivity. Griliches combined the expenditures on research and extension to explain the growth of agricultural productivity; he argued that agricultural extension can enhance technical and allocative efficiency of agricultural production by supplying information to farmers on crop, livestock, and farm management practices. This supports the view presented earlier that extension speeds up the time involved in transferring new knowledge to farmers.

Evenson enumerated a number of sources of improvements in the quality of inputs used by farmers:

i) an increase in the quantity of resources used to produce the input,

ii) formal education through its role in the development of improved labor skills and managerial ability in combining other inputs,

iii) research by private firms selling inputs to farmers,

iv) extension-type efforts by private firms,

v) research effort by public institutions,

vi) extension by state and federal agencies, and

vii) a general increase in knowledge and understanding elsewhere in the economy.

He concluded that public research and extension have the greatest effect on agricultural production and included the variables separately in his model. Evenson did not include private research. It must be emphasized that the proportion of private research in agriculture has increased substantially over the years. Bonnen pointed out that two-thirds of all agricultural R&D expenditures are now accounted for by the private sector. Unfortunately, data for this variable are scarce. Therefore, despite the importance of private research in agriculture, it is not included in this study.

Davis pointed out that if research and extension were added together, as Griliches did, then we assume that either:

i) research and extension are perfect substitutes, or

ii) research and extension are complementary inputs, but must be combined in fixed proportions.

Davis did not accept either of these assumptions arguing that from a conceptual point of view it was more reasonable to separate research and extension. He, therefore, included production-oriented extension expenditures in a Cobb-Douglas production function as an interaction term with the research variable. Norton, and Bredahl and Peterson included only the expenditures on research in their models.

Since the primary objective of this study is to assess the impacts of agricultural research on agricultural productivity, the construction of the agricultural research variable is very important. Davis argued that public research is a public good while extension in general is a private good with externalities. He, therefore, used total state research expenditure and per farm expenditures on extension as separate variables in his model. Evenson, on the other hand, used total state research and total state extension expenditures but lagged the extension expenditures only one period. Total state expenditures on research (Inventory of Agricultural Research) and extension are included as separate variables in this study. The expenditures on research are deflated by the consumer price index (CPI) to remove the influence of inflation, giving a real dollar value for the research variable. A distributed lag of expenditures on research is constructed with various lag lengths and shapes tested.

Extension expenditures (United States Department of Agriculture, Extension Services) are included on per farm basis.

The potential for possible spillover effects of research efforts (the benefits of research efforts spilling over from one state to other states) is recognized, however it is not accounted for in the present study. It is difficult to come up with a good variable with aggregate data to measure spillover effects. Potentially, measuring spillover effects could bias the results since bigger agricultural states are likely to conduct more research than smaller agricultural states. It is not clear in which direction the bias is but possibly it reduces the significance of the research variable.

3.6.7.4 Specification of the Research lag

The research variable is of crucial importance to this study; and as such, the specific lag structure used is presented in detail.

It was pointed out earlier in this chapter that the third-order polynomial is an 'appropriate' distributed lag to capture the hypothesized shape of the impact of agricultural research on agricultural output. The third-order polynomial with beginning end-point constraint, but no terminal point constraint can be derived as:

$$\beta_i = \alpha_0 + \alpha_1 i + \alpha_2 i^2 + \alpha_3 i^3 \qquad 3.36$$

for $\beta_{-1} = 0$,

$$\beta_{-1} = \alpha_0 - \alpha_1 + \alpha_2 - \alpha_3 \qquad 3.37$$

Setting equation 3.37 equals zero,

$$\alpha_0 = \alpha_1 - \alpha_2 + \alpha_3$$

Substituting α_0 in equation 3.36, yields

$$\beta_i = (\alpha_1 - \alpha_2 + \alpha_3) + \alpha_1 i + \alpha_2 i^2 + \alpha_3 i^3. \qquad 3.38$$

From 3.38,

$$\beta_i = \alpha_1 - \alpha_2 + \alpha_3 + \alpha_1 i + \alpha_2 i^2 + \alpha_3 i^3$$

Grouping factors gives:

$$\beta_i = \alpha_1(i+1) + \alpha_2(i^2 - 1) + \alpha_3(i^3 + 1)$$

Substituting the above equation into 3.7 gives:

$$Y_t = \alpha_1 \sum_{i=0}^{k} (i+1) X_{t-i} + \alpha_2 \sum_{i=0}^{k} (i^2 - 1) X_{t-i} + \alpha_3 \sum_{i=0}^{k} (i^3 + 1) X_{t-i} \qquad 3.39$$

Equation 3.39 can be rewritten as:

$$Y_t = \alpha_1 Z_{1t} + \alpha_2 Z_{2t} + \alpha_3 Z_{3t} \qquad 3.40$$

where :

$$Z_{1t} = \sum_{i=0}^{k} (i+1) X_{t-i}$$

$$Z_{2t} = \sum_{i=0}^{k} (i^2 - 1) X_{t-i}$$

$$Z_{3t} = \sum_{i=0}^{k} (i^3 + 1) X_{t-i}$$

These three research lagged variables Z_{1t}, Z_{2t}, and Z_{3t} are embedded in the profit function to estimate the shape of the impact of agricultural research on agricultural output.

An alternative lag structure is also considered in this thesis, the inverted-V distributed lag used by Evenson (1968). This lag was discussed briefly in a previous section; the derivation of the weights of this lag is presented in detail in this section of the thesis. The inverted-V distributed lag is also used because the three research lagged variables from the third-order distributed lag may be highly correlated when included in the estimation of the econometric model. As noted earlier, the inverted-V lag structure is characterized by the weights satisfying

$$\beta_i = c + di \tag{3.41}$$

$$\beta_i = e - fi \tag{3.42}$$

where c and e are the intercepts,

d is the change in β_i (research impact) relative to a change in i (time) when β_i is rising, and f is the change in β_i (research impact) relative to a change in i (time) when β_i is declining. Imposing a beginning point constraint implies that c = 0; therefore,

$$\beta_i = di \tag{3.43}$$

To find the peak of the lag, with no end-point constraint, an equation is set up as follows:

$$gd = e - gf \tag{3.44}$$

$$e = gd + gf \tag{3.45}$$

where g is the peak of the lag, and d, e, and f are as defined above. Substituting 3.45 into 3.42 gives

$$\beta_i = g(d + f) - fi \tag{3.46}$$

Rearranging terms,

$$\beta_i = gd + f(g - i) \qquad 3.47$$

Substituting 3.43 and 3.47 into 3.7 yields:

$$Y_t = d(\sum_{i=0}^{k} iX_{t-i} + g \sum_{i=k+1}^{m} X_{t-i}) + f(g \sum_{i=k+1}^{m} X_{t-i} - \sum_{i=0}^{k} iX_{t-i}) \qquad 3.48$$

Equation 3.48 can be rewritten as:

$$Y_t = dZ_{1t} + fZ_{2t}$$

where:

$$Z_{1t} = \sum_{i=0}^{k} iX_{t-i} + g \sum_{i=k+1}^{m} X_{t-i}$$

$$Z_{2t} = g \sum_{i=k+1}^{m} X_{t-i} - \sum_{i=0}^{k} iX_{t-i}$$

These two research lagged variables Z_{1t} and Z_{2t} are embedded in the profit function to estimate the shape of the impact of agricultural research on agricultural output. It should be mentioned that the quadratic (second-order) distributed lag was also considered.

3.6.7.5 Education

Decision making and efficient allocation of resources in agriculture (and other industries) are crucial and educational training enhances the ability to perform these tasks. Different types of education have been used in econometric models. Welch considered functional illiterates, high school graduates, and college graduates as separate variables in his model. Griliches included elementary school graduates (7-8 years), high school graduates (12 years), college (4 years), and college (4 years and above) in his study.

Some studies have used education as a quality index to adjust the labor variable; other studies have included education as a separate variable. Griliches adopted both procedures, found that there was no appreciable difference between the two, and concluded that one can combine the quantity and quality dimensions of labor into one variable. In this study, education is used as a separate variable and no distinction is made between the different categories of schooling.

Welch measured education as the number of years of schooling while Hayami used the literacy ratio and the school enrollment ratios for the first and second level of education. The measure used by Welch is chosen - the number of years of schooling of farmers - as the measure of education (Census of United States Agriculture) in this study.

3.6.7.6 Capital Stock

Capital is an important and difficult variable to measure. Capital has both stock and/or flow aspects. Some studies have considered it as a stock variable using various types of machines valued at current prices as the stock of machinery. However, there are problems associated with this, because differences in ages of machinery mean that their capacities to perform similar tasks are different and more importantly, the stock of capital is not all used up in one year. Researchers, therefore, have attempted to measure the service flow of capital. Davis used the expenditures on repairs and operations of machinery as a measure of the service flow of machinery. Norton, Coffey, and Frye used the sum of the service flow from buildings, machinery, livestock inventory, crops stored on and off farm, and working capital.

Norton measured machinery as the service flow of machinery plus the expenditures for energy sources plus hired machinery and custom work. The market value of machinery was divided by the number of farms and multiplied by .15 to capture depreciation and interest. This procedure is used in this thesis except that the expenditures for energy sources are treated as a separate variable. The capital stock is measured as:

$$C_s = .15(MVME) + CW \qquad 3.49$$

where: C_s is the stock of capital,

MVME is the market value of machinery and equipment (Census of United States Agricuture 1978, 1982), and

CW is custom work of machinery and equipment (Census of United States Agriculture 1978, 1982).

The market value of machinery and equipment are multiplied by .15 to reflect a ten-year life and a five percent interest rate.

3.6.7.7 Breeding Stock

Some studies treated breeding stock as a flow variable similar to the capital stock variable. However, in this study, breeding stock is measured as a stock variable:

$$S = C + .4SO + .2ES \qquad 3.50$$

where: S is the breeding stock,

C is number of cows and heifers (Census of United States Agriculture 1978, 1982) that have calved,

SO is the number of sows, and

ES is the number of Ewes 1 year old or older. It is assumed that a sow and an ewe are .4 and .2 of a cow respectively.

3.6.7.8 Omitted Variables

Other miscellaneous variables are left out of the analyses. Some of these variables are pesticides, private research, and spillover research. Pesticides are used widely in U.S. agriculture and as such may have significant effect on output levels of agricultural products. The expenditures on pesticides are not included in this study because it is difficult to get data on the different combinations of pesticides used in the U.S. Exclusion of this variable may be biasing upward the coefficients on the fertilizer variable in particular, assuming those variables are possitively correlated.

Private research has become important in agricultural research. Bonnen mentions that it is two-thirds of all R&D in agricultural research. It is important that expenditures by the private sector be included in this type of study. Unfortunately, expenditures by the private sector in research are not readily available. Another research variable left out in this study is spillover research. Spillover research is the research results that are transferred from the state(s) conducting the research to other state(s). The extent of this is not exactly known; however, it may be significant in some regions of the U.S. This variable is left out of this study because its inclusion would have necessitated an arbitrary identification of the amounts of dollars spent on research which spills into particular states. Such an identification is particularily difficult for groups of commodities.

The exclusion of private sector research and of spillover research may be biasing upward the coefficients on the research variables if those variables are positively correlated.

3.7 Econometric Estimation

3.7.1 Introduction

The econometric model used to estimate the length and the shape of the research lag is specified in actual variables. First, the normalized profit function is specified; then the output supply and the input demand equations are derived from the specified profit function. The procedure used to estimate the numeraire (milk) equation and the assumptions about the error terms and the technique used to estimate the system of equations are presented.

3.7.3 Specification of the Normalized Profit Function

From the general function (3.23), the normalized quadratic profit function for the United States agriculture can be specified as:

$$\pi = \alpha_0 + \alpha_1 GR + \alpha_2 OG + \alpha_3 RC + \alpha_4 PO + \alpha_5 LS + \alpha_6 HA + \alpha_7 LA + \alpha_8 FD + \alpha_9 FT$$

$$+ \alpha_{10} FU + \frac{1}{2}\alpha_{01} GR^2 + \frac{1}{2}\alpha_{02} OG^2 + \frac{1}{2}\alpha_{03} RC^2 + \frac{1}{2}\alpha_{04} PO^2 + \frac{1}{2}\alpha_{05} LS^2 + \frac{1}{2}\alpha_{06} HA^2$$

$$+ \frac{1}{2}\alpha_{07} LA^2 + \frac{1}{2}\alpha_{08} FD^2 + \frac{1}{2}\alpha_{09} FT^2 + \frac{1}{2}\alpha_{010} PO^2 + \frac{1}{2}\beta_1 GROG + \frac{1}{2}\beta_2 GRRC$$

$$+ \frac{1}{2}\beta_3 GRPO + \frac{1}{2}\beta_4 GRLS + \frac{1}{2}\beta_5 GRHA + \frac{1}{2}\beta_6 GRLA + \frac{1}{2}\beta_7 GRFD + \frac{1}{2}\beta_8 GRFT$$

$$+ \frac{1}{2}\beta_9 GRFU + \frac{1}{2}\gamma_1 OGRC + \frac{1}{2}\gamma_2 OGPO + \frac{1}{2}\gamma_3 OGLS + \frac{1}{2}\gamma_4 OGHA + \frac{1}{2}\gamma_5 OGLA$$

$$+\frac{1}{2}\gamma_6 OGFD+\frac{1}{2}\gamma_7 OGFT+\frac{1}{\gamma_8}OGFU+\frac{1}{\theta_1}RCPO+\frac{1}{2}\theta_2 RCLS+\frac{1}{2}\theta_3 RCHA$$

$$+\frac{1}{2}\theta_4 RCLA+\frac{1}{2}\theta_5 RCFD+\frac{1}{2}\theta_6 RCFT+\frac{1}{2}\theta_7 RCFU+\frac{1}{2}\delta_1 POLS+\frac{1}{2}\delta_2 POHA$$

$$+\frac{1}{2}\delta_3 POLA+\frac{1}{2}\delta_4 POFD+\frac{1}{2}\delta_5 POFT+\frac{1}{2}\delta_6 POFU+\frac{1}{2}\eta_1 LSHA+\frac{1}{2}\eta_1 LSLA$$

$$+\frac{1}{2}\eta_3 LSFD+\frac{1}{2}\eta_4 LSFT+\frac{1}{2}\eta_5 LSFU+\frac{1}{2}\kappa_1 HALA+\frac{1}{2}\kappa_2 HAFD+\frac{1}{2}\kappa_3 HAFT$$

$$+\frac{1}{2}\kappa_4 HAFU+\frac{1}{2}\psi_1 LAFD+\frac{1}{2}\psi_2 LAFT+\frac{1}{2}\psi_3 LAFU+\frac{1}{2}\phi_1 FDFT+\frac{1}{2}\phi_2 FDFU$$

$$+\frac{1}{2}\tau_1 FTFU+\alpha_{11}GRRE+\alpha_{12}GRED+\alpha_{13}GRLD+\alpha_{14}GRRA+\alpha_{15}GRCS$$

$$+\alpha_{16}GRBS+\alpha_{21}OGRE+\alpha_{22}OGED+\alpha_{23}OGLD+\alpha_{24}OGRA+\alpha_{25}OGCS$$

$$+\alpha_{26}OGBS+\alpha_{31}RCRE+\alpha_{32}RCED+\alpha_{33}RCLD+\alpha_{34}RCRA+\alpha_{35}RCCS$$

$$+\alpha_{36}RCBS+\alpha_{41}PORE+\alpha_{42}POED+\alpha_{43}POLD+\alpha_{44}PORA+\alpha_{45}POCS$$

$$+\alpha_{46}POBS+\alpha_{51}LSRE+\alpha_{52}LSED+\alpha_{53}LSLD+\alpha_{54}LSRA+\alpha_{55}LSCS$$

$$+\alpha_{56}LSBS+\alpha_{61}HARE+\alpha_{62}HAED+\alpha_{63}HALD+\alpha_{64}HARA+\alpha_{65}HACS$$

$$+\alpha_{66}HABS+\alpha_{71}LARE+\alpha_{72}LAED+\alpha_{73}LALD+\alpha_{74}LARA+\alpha_{75}LACS$$

$$+\alpha_{76}LABS+\alpha_{81}FDRE+\alpha_{82}FDED+\alpha_{83}FDLD+\alpha_{84}FDRA+\alpha_{85}FDCS$$

$$+\alpha_{86}FDBS+\alpha_{91}FTRE+\alpha_{92}FTED+\alpha_{93}FTLD+\alpha_{94}FTRA+\alpha_{95}FTCS$$

$$+\alpha_{96}FTBS+\alpha_{101}FURE+\alpha_{102}FUED+\alpha_{103}FULD+\alpha_{104}FURA+\alpha_{105}FUCS$$

$$+ \alpha_{106}FUBS + \lambda_1 RE + \lambda_2 ED + \lambda_3 LD + \lambda_4 RA + \lambda_5 CS + \lambda_6 BS + \lambda_{11} REED$$

$$+ \lambda_{12} RELD + \lambda_{13} RERA + \lambda_{14} RECS + \lambda_{15} REBS + \lambda_{21} EDLD + \lambda_{22} EDRA$$

$$+ \lambda_{23} EDSC + \lambda_{24} EDBS + \lambda_{31} LDRA + \lambda_{32} LDCS + \lambda_{33} LDBS + \lambda_{41} RACS$$

$$+ \lambda_{42} RABS + \lambda_{51} CSBS. \qquad 3.51$$

where: GR is foodgrains (wheat and rice),

RC is feedgrains (corn, sorghum, soybeans, barley, and oats),

OG is other crops (sunflower, sugarbeets, sugarcane, cotton, tobacco, peaches, apples, grapes, grapefruits, oranges, vegetables, potatoes, and peanuts),

PO is poultry (broilers, chickens, turkeys, and eggs),

LS is other livestock (cattle, sheep, and hogs),

HA is hay,

LA is labor,

FD is feed,

FT is fertilizer,

FU is fuel,

RE is research,

LD is land,

RA is rain,

CS is capital stock, and

BS is breeding stock.

The output supply equations (3.24), the first derivatives of the normalized quadratic profit function with respect to the output prices are:

Food Grains

$$GR = \alpha_1 + \alpha_{01}GR + \beta_1 OG + \beta_2 RC + \beta_3 PO + \beta_4 LS + \beta_5 HA + \beta_6 LA + \beta_7 FD$$

$$+ \beta_8 FT + \beta_9 FU + \alpha_{11}RE + \alpha_{12}ED + \alpha_{13}LD + \alpha_{14}RA + \alpha_{15}CS + \alpha_{16}BS + \mu_1, \qquad 3.52$$

Other Crops

$$OG = \alpha_2 + \alpha_{02}OG + \beta_1 GR + \gamma_1 RC + \gamma_2 PO + \gamma_3 LS + \gamma_4 HA + \gamma_5 LA + \gamma_6 FD$$

$$+ \gamma_7 FT + \gamma_8 FU + \alpha_{21}RE + \alpha_{22}ED + \alpha_{23}LD + \alpha_{24}RA + \alpha_{25}CS + \alpha_{26}BS + \mu_2, \qquad 3.53$$

Feed Grains

$$RC = \alpha_3 + \alpha_{03}RC + \beta_2 GR + \gamma_1 OG + \theta_1 PO + \theta_2 LS + \theta_3 HA + \theta_4 LA + \theta_5 FD$$

$$+ \theta_6 FT + \theta_7 FU + \alpha_{31}RE + \alpha_{32}ED + \alpha_{33}LD + \alpha_{34}RA + \alpha_{35}CS + \alpha_{36}BS + \mu_3, \qquad 3.54$$

Poultry

$$PO = \alpha_4 + \alpha_{04}PO + \beta_3 GR + \gamma_2 OG + \theta_1 RC + \delta_1 LS + \delta_2 HA + \delta_3 LA + \delta_4 FD$$

$$+ \delta_5 FT + \delta_6 FU + \alpha_{41}RE + \alpha_{42}ED + \alpha_{43}LD + \alpha_{44}RA + \alpha_{45}CS + \alpha_{46}BS + \mu_4, \qquad 3.55$$

Livestock

$$LS = \alpha_5 + \alpha_{05}LS + \beta_4 GR + \gamma_3 OG + \theta_2 RC + \delta_1 PO + \eta_1 HA + \eta_2 LA + \eta_3 FD$$

$$+ \eta_4 FT + \eta_5 FU + \alpha_{51}RE + \alpha_{52}ED + \alpha_{53}LD + \alpha_{54}RA + \alpha_{55}CS + \alpha_{56}BS + \mu_5 \qquad 3.56$$

Hay

$$HA = \alpha_6 + \alpha_{06}HA + \beta_5 GR + \gamma_4 OG + \theta_3 RC + \delta_2 PO + \eta_1 LS + \kappa_1 LA + \kappa_2 FD$$

$$+ \kappa_3 FT + \kappa_4 FU + \alpha_{61}RE + \alpha_{62}ED + \alpha_{63}LD + \alpha_{64}RA + \alpha_{65}CS + \alpha_{66}BS + \mu_6. \qquad 3.57$$

The input demand equations (3.24), the first derivatives of the normalized quadratic profit function with respect to the input prices are:

Labor

$$LA = \alpha 7 + \alpha_{07}LA + \beta_5 GR + \gamma_4 OG + \theta_3 RC + \delta_2 PO + \eta_1 LS + \kappa_1 HA + \psi_1 FD$$

$$+ \psi_2 FT + \psi_3 FU + \alpha_{61}RE + \alpha_{62}ED + \alpha_{63}LD + \alpha_{64}RA + \alpha_{65}CS + \alpha_{66}BS + \mu_6, \tag*{3.58}$$

Feed

$$FD = \alpha_8 + \alpha_{08}FD + \beta_6 GR + \gamma_5 OG + \theta_4 RC + \delta_3 PO + \eta_2 LS + \kappa_2 HA + \psi_1 LA$$

$$+ \phi_1 FT + \phi_2 FU + \alpha_{71}RE + \alpha_{72}ED + \alpha_{73}LD + \alpha_{74}RA + \alpha_{75}CS + \alpha_{76}BS + \mu_7, \tag*{3.59}$$

Fertilizer

$$FT = \alpha_9 + \alpha_{09}FT + \beta_7 GR + \gamma_6 OG + \theta_5 RC + \delta_4 PO + \eta_3 LS + \kappa_3 HA + \psi_2 LA$$

$$+ \phi_1 FD + \tau_1 FU + \alpha_{81}RE + \alpha_{82}ED + \alpha_{83}LD + \alpha_{84}RA + \alpha_{85}CS + \alpha_{86}BS + \mu_8, \tag*{3.60}$$

Fuel

$$FU = \alpha_{10} + \alpha_{010}FU + \beta_8 GR + \gamma_7 OG + \theta_6 RC + \delta_5 PO + \eta_4 LS + \kappa_4 HA + \psi_3 LA$$

$$+ \phi_2 FD + \tau_1 FT + \alpha_{91}RE + \alpha_{92}ED + \alpha_{93}LD + \alpha_{94}RA + \alpha_{95}CS + \alpha_{96}BS + \mu_{10}. \tag*{3.61}$$

where all variables are as defined above, and μ_1, μ_2, μ_3, μ_4, μ_5, μ_6, μ_7, μ_8, μ_9, and μ_{10} are the error terms of the output supply and input demand equations.

The price of milk was used to normalize the other output and input prices; as a result, the price of milk is not in any of the equations, and there is no equation for the output supply of milk. The price parameters of the milk output supply equation can be identified from the estimates of the ten equations through symmetry and homogeneity. The coefficient on milk in each of the equations is calculated in the following manner: First, homogeneity of degree zero is imposed on each of the equations and the coefficient on the price of milk is calculated. The foodgrain equation is used to illustrate:

Foodgrains

$$GR = \alpha_1 + \alpha_1 GR + \beta_1 OG + \beta_2 RC + \beta_3 PO + \beta_4 LS + \beta_5 HA + \beta_6 LA + \beta_7 FD$$

$$+ \beta_8 FT + \beta_9 FU + \beta_{10} ML. \qquad 3.62$$

In this equation, the estimated parameters are multipled by the sample mean of inputs, and output prices. The coefficient on the price of milk is calculated by imposing the homogeneity condition. All the coefficients in equation 3.62 are known except for the coefficient on the price of milk. The sample means of the prices of inputs and outputs are multiplied by their respective coefficients, and then the coefficient on the price of milk is calculated. This process is repeated for all the other nine equations to obtain the coefficients on the price of milk for each equation. The output supply of the milk equation is estimated as follows:

Milk

$$QM = \alpha_{11} + \alpha_{011} ML + \beta_9 GR + \gamma_8 OG + \theta_7 RS + \delta_6 PO + \eta_5 LS + \kappa_5 HA + \psi_4 LA$$

$$+ \psi_3 FD + \tau_2 FT + \tau_{1FU} + \alpha_{101} RE + \alpha_{102} ED + \alpha_{103} LD + \alpha_{104} RA + \alpha_{105} CS$$

$$+ \alpha_{106} BS + \alpha_{106} BS + \mu_{11.} \qquad 3.63$$

QM is the the quantity of milk and all the other variables are as defined. The coefficients on the output and input prices are derived through the symmetry conditions, and by homogeneity, the own-price coefficient of milk is derived. However, the coefficients on the fixed factors cannot be obtained directly. A new variable (QM1) is created:

$$QM1 = QM - (\alpha_{011} ML + \beta_9 GR + \gamma_8 OG + \theta_7 RS + \delta_6 PO + \eta_5 LS + \kappa_5 HA + \psi_4 LA)$$

$$+ (\psi_3 FD + \tau_2 FT + \tau_1 FU) \qquad 3.64$$

QM1 is regressed on the fixed factors to obtain the coefficients on the fixed factors.

3.7.3 The Technique Used to Estimate the Input Demand and the Output Supply Equations

The error term for each supply/demand equation is assumed to be homoscedastic, uncorrelated, and normally distributed. Because production decisions on products and inputs are interrelated, contemporaneous cross-equation correlation of the disturbances is likely across equations. The cross-equation restrictions (symmetry conditions, $\beta_{ij} = \beta_{ji}$) are imposed to reduce the number of unknown parameters to be estimated. Because of the cross-equation restrictions and the possible contemporaneous correlation of the disturbance terms in the output supply and input demand equations, the choice functions must be estimated as a system. Zellner's generalized least squares for seemingly unrelated equations is employed to estimate the output supply and input demand equations jointly as a system. This method has the desirable properties of consistency, asymptotic efficiency, and asymptotic normality (Kmenta).

3.8 Summary of Chapter

This chapter explained in detail the methods used in this thesis. The scientist questionnaire was discussed and the procedure used to analyze the responses was presented. The model used to measure the research lag was explained, and the (profit) function and functional form chosen were justified. The econometric model for this study was specified. The data used for this study and the sources, transformation, and commodity grouping were also presented. The research lag, the normalized profit function, and the output supply and input demand equations in actual variables for the US agriculture were specified. The next two chapters present the results of the responses from the scientist questionnaire, and the econometric model.

Since maintenance research may become increasingly important as agriculture becomes more complex, it is vital that further attention be given to its measurement.

Dana G. Dalrymple "Evaluating the Impact of International Research on Wheat and Rice Production in the Developing Nations" *Resource Allocation and Productivity in National and International Agricultural Research* T. M. Arndt, D.G. Dalrymple, and V.W. Ruttan (ed.) University of Minnesota Press, Minneapolis, 1977, p. 179.

Chapter 4

RESULTS AND DISCUSSION OF SCIENTIST QUESTIONNAIRE

4.1 Introduction

This chapter presents statistical and descriptive analyses of the results of the scientist questionnaire on maintenance research. First, a summary of the distribution by discipline, by commodity, and by geographical region is presented, and then hypotheses, advanced in chapter 1, are tested. Based on the results of the survey, other hypotheses are developed which are tested in the profit function model. Then, extrapolations of total maintenance research expenditures for each commodity based on the survey is presented. The next section of this chapter summarizes several examples of maintenance research as described by scientists responding to the questionnaire. Finally, some overall conclusions are presented based on the results of the survey.

4.1.2 Statistical Results of the Scientist Questionnaire

Summary results of the responses to the scientist questionnaire are presented in Tables 4.1 - 4.8. The number of questionnaires mailed to agricultural scientists was 2426; the number returned was 905, or 37.3 percent of the total number of questionnaires mailed to agricultural scientists. However, only 744 are used in the analysis. Some of the respondents were retired and did not fully complete the returned questionnaire. In other cases, scientists did not indicate which commodity or commodities they are conducting research on, or otherwise failed to fully complete the questionnaire.

A total of 291 agronomists and related crop scientists responded to this questionnare; representing the largest group surveyed with 39.1 perent of the returned questionnaires (Table 4.1). The number of questionnaires returned from the other disciplines or academic departments were as follows: animal science 68 (9.1 percent), entomology 109 (14.7 percent), horticulture and related departments 109 (14.7 percent), plant pathology 121 (16.3 percent), poultry science 33 (4.4 percent), and soil science 13 (1.7 percent).

The distribution of scientists by academic departments responding to the questions requesting examples of research depreciation and maintenance research is presented in Table 4.2. A total of 208 agronomists and related scientists gave examples of research depreciation, 80 indicated that they have not observed any research depreciation, and 3 did not respond. A total of 171 agronomists and related scientists provided examples of maintenance research. The highest percentage of scientists observing maintenance research and depreciation were in plant pathology and entomology. A total of 97 out of 121 plant pathologists have observed research depreciation and 86, maintenance research. A total of 87 out of 109 entomologists have observed research depreciation and 75, maintenance research. The other agricultural scienstists who gave examples of research depreciation were distributed as follows: 41 out of 68 animal scientists, 75 out of 109 horticultural scientists, 16 out of 33 poultry, and 10 out of 13 soil scientists.

Table 4.1 Distribution of the Number and Percentage of Questionnaires Returned, by Department.[a]

Department	Number Mailed	Number Retured	Responses(%)
Agronomy, Crop Science, Plant Science, and Botany	885	291	39.1
Entomology	391	109	14.7
Plant Pathology	362	121	16.3
Horticulture,Pomology and Vegetable Science	330	109	14.7
Soil Science	67	13	1.7
Animal Science and Dairy Science	278	68	9.1
Poultry Science	113	33	4.4
Total	2426	744	100

[a] Several additional variations of the disciplines listed above were included in academic department titles.

Table 4.2 Distribution of Responses to Questions Requesting Examples of Research Depreciation and Maintenance Research.[a]

Department	Research Depreciation			Maintenance Research		
	Yes	No	Missing	Yes	No	Missing
Agronomy, Crop Science, Plant Science, and Botany	208	80	3	171	35	85
Entomology	87	22	0	75	12	22
Plant Pathology	95	24	2	86	9	26
Horticulture, Pomology, and Vegetable Science	75	32	2	66	9	34
Soil Science	10	3	0	7	2	4
Animal Science and Dairy Science	41	24	3	28	11	29
Poultry Science	16	16	1	14	1	18
Total	532	201	11	447	79	218

[a] Several additional variations of the disciplines listed above were included in academic department titles.

The distribution of other agricultural scientists who gave example of maintenance research was 28 out of 68 animal scientists, 66 out of 109 horticultural scientists, 14 out of 33 poultry scientists, and 7 out of 33 soil scientists.

The average percentage of research effort devoted to maintenance research for all the commodities is 34.8 percent. Barley has the highest average percentage of research effort devoted to mainteance research, 42.2 percent. Livestock has the lowest percentage of research effort devoted to maintenance research, 21.4 percent. The remaining commodities, corn, cotton, fruits, hay, oats, other crops, peanuts, potatoes, poultry, rice, soybeans, sorghum, tobacco, vegetables, and wheat have the following average percentage of research effort devoted to mainteance research, respectively: 34.0 percent, 39.3 percent, 35.1 percent, 33.2 percent, 35.4 percent, 33.0 percent, 27.6 percent, 39.3 percent, 33.4 percent, 33.6 percent, 27.9 percent, 40.6 percent, 30.2 percent, 41.5 percent, and 41.1 percent (Table 4.3).

The distribution of percentage of research effort devoted to maintenance research of the surveyed scientists, by state, is presented in Table 4.4. The percentages indicate that New Mexico devotes the highest percentage of research effort to maintenance research, 70%; and Tennessee devotes the lowest percentage of research effort to maintenance research, 16.9%.

Using the United States Department of Commerce regions and division of the United States map (Census of US Agriculture), the percentage of research effort devoted to maintenence research of the surveyed scientists for each region is presented in Table 4.5. The MidAtlantic has the highest percentage of research effort devoted to maintenance research, and the East South Central has the lowest. The distribution of the other regions is: New England (36.7%), South Atlantic (24.0%), East North Central (34.8%), West North Central (37.4%), Mountain (34.6%), and the Pacific (39.2%).

Table 4.3 Distribution of the Percentage of Research Effort Devoted to Maintenance Research, by Commodity.

Commodity	Research Effort Devoted to Maintenance Research (%)	Range	Standard Deviation
Barley	42.2	100	28.4
Corn	34.2	100	28.4
Cotton	39.3	100	29.1
Fruits	35.1	100	30.1
Hay	33.1	100	30.1
Livestock	21.4	100	26.5
Oats	35.4	100	27.8
Other Crops	32.8	100	28.7
Peanut	27.6	60	19.1
Potato	39.3	100	30.5
Poultry	33.4	100	30.3
Rice	33.6	100	32.0
Soybeans	27.9	100	26.2
Sorghum	40.6	100	27.7
Tobacco	30.2	90	30.8
Vegetables	41.5	100	32.2
Wheat	41.1	100	28.2
All Commodities	34.8	100	29.4

Table 4.4 Distribution of the Percentage of Research Effort Devoted to Maintenance Research, by State.[a]

State	Number of Respondents	Research Effort Devoted to Maintenance Research (%)	Range	St. Dev.
Alabama	15	38.4	100	29.4
Arkansas	15	29.6	100	31.4
Arizona	15	38.0	75	22.4
California	39	28.5	75	20.6
Colorado	3	26.3	100	28.0
Connecticut	6	31.3	40	17.5
Delaware	2	35.0	80	40.4
Florida	25	30.8	70	49.5
Georgia	33	24.6	100	32.8
Hawaii	21	36.9	100	24.7
Idaho	5	33.8	60	17.5
Illinois	19	21.4	80	24.7
Indiana	14	38.9	90	29.5
Iowa	15	32.3	80	30.3
Kansas	25	42.4	100	35.0
Kentucky	13	17.5	40	15.1
Louisiana	25	27.8	100	30.6
Maine	7	26.4	80	19.8
Maryland	15	38.7	100	31.8
Massachusetts	5	48.1	90	41.0
Michigan	14	30.6	80	28.8
Minnesota	17	35.4	60	23.1
Mississippi	8	24.2	85	24.8
Missouri	22	48.7	100	33.4
Montana	4	31.4	80	34.4
Nebraska	13	44.1	95	21.7
Nevada	14	55.0	90	63.6
New Hampshire	4	50.0	0	0.00
New Jersey	2	46.0	10	5.5
New Mexico	4	70.0	70	36.1
New York	32	43.6	100	35.9
North Carolina	51	36.2	100	28.4
North Dakota	14	17.6	50	16.6
Ohio	13	33.3	80	27.4
Oklahoma	21	33.8	100	30.2
Oregon	17	45.8	95	36.7
Pennsylvania	19	44.6	100	37.2
Rhode Island	3	40.0	100	54.8
South Carolina	12	45.0	65	20.0
South Dakota	6	24.7	60	21.4
Tennessee	11	16.9	50	16.1
Texas	31	34.4	100	27.4
Utah	9	36.3	100	34.6
Vermont	3	31.0	75	39.2
Virginia	21	31.8	80	28.3
Washington	32	49.4	100	28.2
West Virginia	10	29.9	100	29.9
Wisconsin	27	32.5	80	27.4
Wyoming	5	25.6	40	17.5
All States	744	34.8	100	29.4

[a]The percentages are from the responses to the survey.
St. Dev. is the standard deviation.

Table 4.5 Distribution of the Percentage of Research Effort Devoted to Maintenance Research, by Region.[a]

Region	Research Effort Devoted to Maintenance Research (%)
East North Central	31.1
East South Central	24.0
MidAtlantic	44.1
Mountain	34.6
NewEngland	36.7
Pacific	39.2
SouthAtlantic	32.9
West North Central	37.4
West South Central	31.8
All States	34.8

[a] Regional definition are:

East North Central : Wisconsin, Michigan, Illinois, Indiana, and Ohio.

East South Central: Kentucky Tennessee, Alabama, and Mississippi.

MidAtlantic: New York, Pennsylvania, and New Jersey.

Mountain: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada.

New England: Massachusettees, New Hampshire, Maine, Connecticut, Vermont, and Rhode Island.

Pacific: Washington, Oregon, California, and Hawaii.

SouthAtlantic: Maryland, Delaware, West Virginia, Virginia, North Carolina, South Carolina, Georgia, and Florida.

West North Central: North Dakota, South Dakota, Minnesota, Iowa, Nebraska, Kansas, and Missouri.

West South Central: Oklahoma, Texas, Louisiana, and Arkansas.

4.1.3 Estimates of National Maintenance Research Budget

It was pointed out earlier that the results of 744 returned questionnaires are summarized in this study. However, it is feasible to utilize the results to extrapolate to national expenditures on maintenance research for each commodity in this study. The United States Department of Agriculture publishes a summary of public research funds (Inventory of Agricultural Research) expended on each commodity. These funds include operating cost, salaries, and other expenditures related to public research activities on each commodity. The percentage of total research effort devoted to maintenance research on each commodity (based on the scientists surveyed) is used together with 1985 data from the Inventory of Agricultural Research to obtain an estimate of national publicly funded maintenance research on each commodity. The maintenance expenditure on each commodity is calculated as follows:

$$E_i = (\frac{PRE_i}{100})TF_i \qquad 4.1$$

where PRE_i is the percentage of the total research effort on crop i devoted to maintenance research on crop i (Table 4.4),

TF_i is total public funds for research on crop i (Inventory of Agricutural Research), and E_i is the estimated national expenditure on maintenance research for crop i.

The results of this calculation are presented in Table 4.6. The numbers in Table 4.6 indicate that livestock has the highest amount of research funds, $45,584,982 devoted to maintenance research, although livestock has the lowest percentage of total research effort devoted to maintenance research. More total funds are simply devoted to livestock research. The commodity with the second largest amount of maintenance research is vegetables, with $28,200,634 of the total funds devoted to maintenance research. The commodity with the lowest maintenance research funds is peanuts. The distribution of funds devoted to maintenance research is: barley $5,713,285, corn $11,792,973, cotton $7,429,000, fruits $25,126,900, hay $14,297,370, oats $4,792,660, other crops $5,411,005,

Table 4.6 Estimates of US Agricultural Maintenance Research[a]

Commodity	Maintenance Research1($)	Maintenance Research2($)
Barley	5,713,285	8,123,746
Corn	11,792,973	17,535,501
Cotton	7,429,000	18,678,026
Fruit	25,126,900	36,433,382
Hay	14,297,370	20,597,468
Livestock	45,584,982	68,511,306
Oats	4,792,660	6,814,706
Other Crops	5,411,005	10,495,256
Peanut	2,020,331	3,354,831
Potato	5,330,933	7,287,732
Poultry	13,902,734	21,270,410
Rice	2,739,076	3,628,511
Soybeans	10,335,475	16,111,274
Sorghum	4,304,192	5.535,076
Tobacco	3,236,049	4,986,633
Vegetables	28,200,634	36,899,727
Wheat	11,899,444	18,997,361
All Commodities	20,2117,000	305,260,000

[a] Maintenance Research1 covers SAES.
Maintenance Research2 covers SAES, USDA, and Other Institutions.

$$E_i = \left(\frac{PRE_i}{100}\right)TF_i$$

where PRE_i is the estimated percentage of total research effort on crop i devoted to maintenance research on crop i,

TF_i is total public funds for research on crop i (Inventory of Agricultural Research), and
E_i is the estimated national expenditure on maintenance research for crop i.

peanuts $2,020,311, potato $5,330,933, poultry $13,902,734, rice $$2,739,076, soybeans $10,335,475, sorghum $4,304,192, tobacco $3,236,049, and wheat $11,899,444. These figures correspond to expenditures by the State Agricultural Experiment Stations (SAES).

4.1.4 Hypotheses Testing

Three hypotheses were advanced in chapter 1. The two to be tested using the results of the scientist questionnaire are:

a. that maintenance research is an important component of total agricultural research in the United States (for purposes of hypothesis testing, the definition of important is arbitrarily set at greater than 25 percent of total research), and

b. that the importance of maintenance research as a proportion of total research varies substantially by commodity.

The first hypothesis is tested by comparing the mean of the research effort devoted to maintenance research for all the commodities (34.8), with 25. This test is conducted by using the t-test (Scheffe procedure) on the following null and alternative hypotheses:

$$H_0: \qquad \beta > 25 \qquad 4.2$$

$$H_A: \qquad \beta \leq 25 \qquad 4.3$$

where β is the mean of research effort devoted to maintenance research. Equation 4.2 is the null hypothesis that research effort devoted to maintenance research is greater than 25 percent of total research, and equation 4.3 is the alternative hypothesis that research effort devoted to maintenance research is less than or equal to 25 percent of total research. The result indicates that the mean of research effort devoted to maintenance research is significantly greater than 25 percent of total research.

The second hypothesis is tested by comparing the means of the percentage of the total research effort by commodity devoted to maintenance research. Again, a t-test is used to test the null and alternative hypotheses:

$$H_0: \qquad \beta_i = \beta_j \qquad i \neq j \tag{4.4}$$

$$H_A: \qquad \beta_i \neq \beta_j \qquad i \neq j \tag{4.5}$$

where β_i and β_j are the means of the percentage of the total research effort devoted to maintenance research for the commodities in this study. The null hypothesis, equation 4.4, is that the mean of maintenance research effort of commodity i is equal to that of commodity j. The alternative hypothesis, equation 4.5, is that the mean of maintenance research effort of commodity i is not equal to that of commodity j. The results of those tests that are significant at the 5% level are presented in Table 4.7. There are significant (at the 0.05 level) differences in maintenance research between livestock and all the other commodities except rice, tobacco, soybeans, and peanuts. There are also significant (at the 0.05 level) differences in maintenance research between barley and soybeans; vegetables and corn, hay, other crops, soybeans, and peanuts. Maintenance research effort devoted to wheat is significantly different from that of hay, other crops, soybeans, and vegetables; and maintenance research for sorghum is significantly different from that for soybeans.

The percentages of research effort devoted to maintenance research for cotton, potato, and fruits are significantly different from soybeans, corn, and vegetables; the percentages of maintenance research effort are also significantly different between corn and vegetables; between hay and vegetables, and hay and wheat. Maintenance research for other crops is significantly different from vegetables, and wheat; soybean maintenance research is different from barley, vegetables, wheat, sorghum, cotton, potato, and fruits. The maintenance research effort devoted to peanuts is significantly different from that of vegetables, and wheat. There are no significant differences in the percentage of research devoted to maintenance between rice, and tobacco, and the other commodities.

Table 4.7 Test of Difference Between Means of the Percentage of Research Effort Devoted to Maintenance Research, for Commodities.[a]

Commodity Comparison	Difference Between Means of Research Effort(%)
Barley-Soybeans	14.245
Vegetables-Corn	7.512
Vegetables-Hay	8.398
Vegetables-Other Crops	8.761
Vegetables-Soybeans	13.592
Vegetables-Peanuts	13.920
Wheat-Hay	7.930
Wheat-Other Crops	8.293
Wheat-Soybean	13.124
Wheat-Peanuts	13.451
Sorhum-Soybeans	12.619
Cotton-Soybeans	11.389
Potato-Soybeans	11.377
Fruit-Soybeans	7.143
Livestock-Barley	-20.832
Livestock-Vegetables	-20.178
Livestock-Wheat	-19.710
Livestock-Sorghum	-19.206
Livestock-Cotton	-17.957
Livestock-Potato	-17.964
Livestock-Oats	-14.085
Livestock-Fruits	-13.729
Livestock-Corn	-12.667
Livestock-Poultry	-12.041
Livestock-Hay	-11.780
Livestock-Other Crops	-11.417

[a] Difference Between the Means of Research Effort Devoted to Maintenance Research are significant at the 5% level.

The commodities are grouped into the six categories - foodgrains, feedgrains, other crops, livestock, poultry, and hay - which will later be utilized in the econometric model described in chapter 3. A t-test is conducted to test if there are significant differences among the means of the percentage of research effort devoted to maintenance research for each group. The results, reported in Table 4.8, indicate that there are no significant differences (at the 5% level) among the groups except between livestock and several crop groups. The mean of the percentage of research effort devoted to maintenance research for livestock is significant at the 5% level from that of foodgrains, feedgrains, other crops, poultry, and hay. This means that, on the average, the percentage of research effort devoted to maintenance research of the scientists surveyed does not vary by these commodity groups except for livestock. The implication of this t-test is that, based on the results of the survey, foodgrains, feedgrains, other crops, poultry, and hay require equal research efforts to prevent their productivities from declining. A t-test of differences in maintenance research among these groups of commodities also is conducted in the next chapter using the results of the econometric model.

This section presented a summary of the results for the scientist questionnaire, extrapolation of the results to obtain estimates of total expenditures on agricultural maintenance research on each commodity in the United States, and tested two of the hypotheses in this study. The next section is a presentation of the examples of maintenance research given by agricultural scientists.

4.2 Examples of Maintenance Research Given by Agricultural Scientists Responding to the Questionnaire

In this section, examples are presented of maintenance research provided by agricultural scientists in response to questions which asked them for the major objective of their research, if they have observed examples of research depreciation in their fields, and if maintenance research was under-

Table 4.8 Test of Difference Between Means of the Percentage of Research Effort Devoted to Maintenance Research, for groups of commodities.[a]

Commodity Comparison	Difference Between Means of Research Effort(%)
Livestock-Foodgrains	-18.703
Livestock-Feedgrains	-15.198
Livestock-Other Crops	-14.526
Livestock-Poultry	-12.014
Livestock-Hay	-11.780

[a] Difference between the Means of Research Effort Devoted to Maintenance Research are significant at the 5% level.

Commodity Group definitions are:

Foodgrains: wheat and rice.

Feedgrains: corn, soybeans, oats, barley, and sorghum.

Other crops: sunflower, sugarcane, sugarbeet, cotton, vegetables, peaches, grapes, apples, oranges, grapefruit, peanuts, potato, and tobacco.

Poultry: chickens, broilers, eggs, and turkeys.

Livestock: cattle and calves, hogs, and sheep and lamb.

taken to replace the depreciated research (see questions 2, 3, and 4 in appendix A). The responses of scientists to these questions provide additional insights into the causes of research depreciation and the resulting maintenance research responses.

The distribution of responses to the questions requesting examples of research depreciation and maintenance research was presented in the preceeding section. It must be mentioned that not all of the examples provided by the scientists are discussed in this section because many of them are similar to each other. In the discussion which follows, a general description of examples of research depreciation and maintenance research are presented, then a detailed presentation of the specific examples given by agricultural scientists is made. Most of the crops that are considered in this study are increasingly becoming susceptible to disease(s) and insects as pests become resistant to pesticides. Generally, there are three approaches to solving these problems. One approach is to develop cultivars that are resistant to disease(s) and/or pest(s); another approach is to evaluate new compounds to combat these diseases and pests. The third approach is to use biological, and cultural practices to effective control diseases, and other pests problems.

The first examples to be presented concern the first approach, developing cultivars that are resistant to diseases, and pests. The first major crop to be discussed is wheat. Dr. T.M. Starling, an agronomist in Virginia, notes that "new races of powdery mildew fungi of wheat, and wheat leaf rust have evolved and these are capable of attacking varieties which were resistant just four years ago." Indications are that research is being conducted jointly by plant pathologists and agronomists to incorporate new sources of resistance to powdery mildew. In addition, the greenbug, the hessianfly, and the Russian wheat aphid have increasingly become a major problem in wheat cultivars. Agronomists are developing cultivars with genes that would be resistant to these factors. In South Dakota, a plant scientist indicates that the Hessianfly drastically reduced spring wheat in 1978 and 1979. Fortunately, in 1984 and 1987 plant breeders released a Hessianfly resistant variety. Dr. R.L. Burton, an entomologist also points out that "the recent occurrance of the Russian wheat aphid on the Great Plains destroyed wheat lines and an intensive program was developed to search for resistance."

Soybeans are exposed to major problems - soybeans cyst nematodes (SCN), and sudden death syndrome. An agronomist in Maryland points out that the soybeans cyst nematodes have increased in acreage that are infested, and that all major soybeans varieties are susceptible to this pest. The research station in Maryland has changed the breeding program to select for resistance, and screening is being conducted for SCN resistance. The sudden death syndrome appears to be prevalent in the south and the midwest. Scientists from Arkansas, Ohio, Tennessee, Georgia, and Indiana indicated that efforts are underway to identify the problem and incorporate genes for resistance into new cultivars. Dr. T. Walker, an agronomist in Arkansas, indicates that "resistant germplasms have been identified and used in breeding programs to develop lines resistant to the sudden death syndrome." An entomologist in Indiana points out that formerly, SCN was thought to be a "southern" pest. Now, large areas in northern regions are known to be infested but agronomically suitable resistant varieties are not available. However, an active research program has been instituted to test new lines from the US regional laboratory at Urbana, Illinois against field populations in all the soybean areas in Indiana.

Another problem that affects soybeans is stem canker, and new races of phytophthora. Again, resistant varieties are being sought to prevent productivity from declining. An agronomist in Alabama notes that soybean stem cankeer, a new disease of soybeans in the south, swept across Alabama in 1977, 1981, and 1983. Changes in populations of soybean nematodes have caused resistant cultivars to be attacked. Maintenance research is being conducted to incorporate stem canker resistance into adapted cultivars, and to combine stem canker resistance of major nematode species.

The next major crop to be discussed is corn. Even though a major effort was undertaken to control the corn blight in the early 1970's, corn is still susceptible to other problems. The problem that agricultural scientists working on corn appear to be most concerned about is the European corn borer. Scientists in the midwest mentioned this problem more frequently than all other problems combined. An entomologist in Minnesota indicates that there are continuing studies of insecticide performance against the European corn borer. A plant pathologist in Nebraska, and a crop scientist in North Carolina cite gross bacterial wilt and blight, and gray leaf spot disease in corn as other major problems. The crop scientist points out that there is an invasion of gray leaf spot disease in corn in the mountain areas of North Carolina. Maintenance research is being undertaken to rate commercial hybrids for tolerance to Cercospora fungus, and there is screening for resistance among different germplasm. The plant pathologist indicates that breeding for resistance has occurred and is still in progress.

The northern corn rootworm is another problem that scientists face in relation to corn. The rootworm appears to be adapting to crop rotation, the major control strategy. Research is currently underway to identify the scope of the problem, establish new economic thresholds, find methods of dealing with the problem (insecticides), and predict future damage.

The greenbug and the downy mildew races are the two major problems in sorghum. An agronomist in Kansas collaborating with another scientist in Nebraska, points out that the development of new biotype E greenbug has overcome most of the resistance to biotype C greenbug. In addition, there are other diseases and insects in sorghum that are overcoming previous and current strains of sorghum. Research is being conducted to identify and develop new resistant parents and hybrids to new biotype E. Downy mildew races have reduced the productivity of sorghum in Georgia and other states. However, an agronomist in Georgia and a plant pathologist in Nebraska point out that there is a scramble to avert the problem in the US and abroad. The scientists indicate that there is mass screening for resistance to anthracnose pathotypes.

The alfalfa crop has been attacked by pests, notable among these pests is the spotted alfalfa aphid. An entomologist in Nebraska notes that "resistance breaking" biotypes of the spotted alfalfa aphid have appeared on resistant varieties of alfalfa in some parts of the US. In an attempt to solve the problem, there are efforts to screen world alfalfa germplasm; in addition, a search is being made for new sources of resistance to the spotted alfalfa aphid. There are efforts in Minnesota to find genes resistant to bacterial wilt, and anthracnose in alfalfa.

Dr. H.D. Wells, a plant pathologist in Georgia, points out that "in 1972, pearl millet rust first appeared in the US. Currently, researchers are in the process of releasing an inberd line with immunity to this disease."

New races of bacterial blight (Xanthmones Campestus pu orgzae) have reduced rice production in the US, and this has resulted in the search to develop resistant rice cultivars. A plant pathologist in Kansas points out that the continuous changes in populations of the bacterial blight has made it necessary for new approaches to identify resistance genes. Research programs to identify rice resistance genes (to bacterial blight) by molecular biological techniques are underway. Barley has also been attacked by viruses. There has been widespread occurrance of barley yellow dwarf virus. An agronomist in Kentucky points out that this has stimulated research in the area of resistance and tolerance, and that an extensive breeding effort to incorporate acceptable levels of tolerance into breeding programs is being evaluated.

A plant scientist in South Dakota notes that the development of new races of sunflower downy mildew has rendered currently used genes for resistance useless. Fortunately, there are efforts to locate new and different forms of resistance, and to develop methods to predict durability of resistance. The Colorado potato beetle (CPB) has been successful in becoming resistant to available insecticides throughout the US. Research efforts are underway, a plant pathologist in New York indicates, to develop CPB resistant varieties using wild species as sources of resistance. The peanut stripe, a virus discovered in 1982, could potentially result in a 6-10 percent yield loss. This is an assessment of a plant pathologist in Georgia. This virus is seed transmissable, but detection methods have been developed to prevent contamination of seed lines used for breeding programs. Dr. W.V. Campbell, an entomologist in North Carolina, gives an example of research efforts underway to control spider mite outbreaks in peanuts due to the use of certain pesticides.

In the case of cotton, heliothis has become resistant to pyrethoids. An agronomist in Mississippi whose major research objective is breeding cotton germplasm with increased host plant resistance, is developing improved heliothis resistant cotton germplasm. A new strain of phytophthora parasitica capable of attacking resistant tobacco varieties have appeared in Kentucky. An agronomist indicates that tobacco varieties that are resistant to phytophthora parasitica were developed but these are "low-yielding." There has been an increase in the severity of losses to potato virus Y complex (PVY) in tobacco. A new variety of tobacco with increased resistance to PVY has been developed.

An agronomist in Iowa whose major research objective is to locate new genes for disease resistance, points out that new races of Fusarium, and Verticillium wilts appeared on tomatoes overcoming I and Ve genes, respectively. Researchers evaluated all the available plants for new genes and found resistance to the new races. However, Dr. W.R. Henderson, a horticultural scientist in North Carolina, points out that "research is still being conducted to breed for disease resistance to Sclerotium rolfsii, and Pseudomonas solanacearum in tomatoes."

All the examples on developing fruit cultivars are from Florida, Georgia, and Utah. Scientist are concerned with lack of sufficient cold hardiness which has resulted in yield decreases and plant death. A horticultural scientist in Georgia notes that breeding is underway to increase cold hardiness. A fruit crop scientist in Florida gives an example of earlier ripening blueberry varieties to circumvent the problem of early frost. There are few examples of breeding by scientists as far as fruits are concerned. However, there are examples of chemical, cultural, and biological practices to control fruit diseases and pests.

The second and third approaches that agricultural scientists have adopted to combat diseases and pests are the evaluation and usage of new compounds, and the use of biological and cultural practices.

An entomologist in Virginia gives an example of research focused on the enhancement of natural enemies such as parasites and pathogens of caterpillars feeding on cruciferous crops. The same scientist points out that there is increasing search for and use of phytophegous insects to suppress weeds and increase productivity of forage and pasture. A horticultural scientist in Texas developed a new zinc spray, marketed as NZN, that is absorbed in greater amounts and is transported more rapidly within the pecan plant tissue. This was necessary since the old zinc fertilization methods failed as pecans were grown more and more in the alkaline soils of the western parts of the U.S.. A scientist in the same field of study in Georgia, notes that tolerance of scab fungus to fungicides, aphids resistance to insecticides, and loss of resistance of pecan cultivars to scab and other diseases have necessitated the screening of insecticides and fungicides, the use of integrated pest management, and testing of cultivars, crosses, and selections of pecan varieties.

Dr. E.I Zehr, a horticultural scientist and a plant pathologist in South Carolina working on peaches and apples indicates that DBCP as a post-plant fumigant against ring nematodes in peaches is not as effective as before, and research is underway to find alternative ways to combat ring nematodes including finding resistant root stocks, biogical control agents, and other methods. Dr. Zehr points out that phenamiphos nematicides appear to control the problem. A plant pathologist in Wisconsin notes that apple and cherry fungicides are so specific in mode of action that resistance has developed in target organisms. Hence, maintenance research such as characterization and alternative disease management strategies (altering application schedules, development of new fungicides, and cultural methods) are being conducted.

Apples in New York and North Carolina also have some problems requiring maintenance research. An entomologist in New York notes that pesticide resistance has led to increased mite problems, and changes in pesticide use have destroyed mite natural enemies. Research is underway with the aim of managing resistance in mites on apple trees, and to find pesticide use strategies that are compatible with integrated mite control. In North Carolina, there has been loss of effectiveness of fungicides due to the development of resistant pathogens. There is evaluation of alternative fungicides and patterns of fungicide use for disease control.

A plant pathologist working on apples and peaches points out that insects and mites have become resistant to chemicals. There is evaluation of other control tactics including biological practices to control the mite problem in West Virginia. In Wisconsin, there is organophosphate insect resistance by spotted leafminer on apples. This has required the usage of alternative pesticides to prevent further decline in apple productivity. Research is being undertaken to augment natural biotic control, and to reestablish pest management programs. A plant scientist in Vermont indicates that the use of sevin as a fruit thinner is harmful to mite preditors. The productivity of apples has started to decline in Vermont; however, there are tests to replace sevin with 6-BA as a thinner of apples.

Another example of maintenance research is from Florida. Dr. D. L. Myhre, a soil scientist working on citrus, notes that ″subsoil acidity has decreased the growth of citrus in ′flatwood′ soil in Florida. Phosphogypsum which is a by-product of the production of phosphoric acid is being evaluated to be used as an ameliorant for the subsoil acidity syndrome″. In New York, a plant pathologist gives examples of debilitating root rot diseases of some raspberry varieties and fruit tree rootstocks, widespread resistance to benomyl and dodine fungicides, and rapid development of resistance to streptomycin by bacterium causing diseases in apples. Maintenance research is being undertaken to determine relative resistance among varieties and rootstock, to develop resistance-management strategies, to test alternative chemicals and bactericide.

In the state of Washington, a plant pathologist points out that pathogens have developed resistance to chemicals and cultivars of red raspberry, cranberry, strawberry, and blueberry and that current cultivars are no longer resistant to certain diseases. But research is underway to test fungicides, to identify useful compounds, and to collaborate with breeders to develop resistant cultivars which will allow growers to use no chemicals for disease control. Pineapples grown in Hawaii have been attacked by ants. Three agricultural scientists (an entomologist, a plant pathologist, and an agronomist) cite ants as a major problem to the productivity of pineapple. Dr. Breadsley, an entomologist, notes that ″control in pineapple was formerly achieved by using Mirex and heptachlor spray. Mealybug wilt, formerly eliminated through ant control has again become an economic problem″. There is a search for alternative pesticides to replace EDB, DBC, and chlorinated hydrocarbon insecticides for ant control. Tests are currently underway to identify alternative pesticides and nematicides that have low residual activity but are effective, for example, Nemacur and Andro. In addition, there are attempts to devise new pest management technologies not dependent upon direct insecticide applications to the pineapple crop.

The responses from agricultural scientists indicate that there is increasing use and search for biological and cultural control of parasites, diseases, and insects in other crops besides fruits. Vegetables are prime examples; a plant pathologist in New York is developing disease control measures in edible dry beans by using a computer simulation model to mimic the selection of a fungicide resistant population to be used as a management tool in planning spray schedules, biological, and cultural controls. In Louisiana, an entomologist gives an example of diamondback moth resistance to pyrethroids on cole crops and the introduction of the western flower thrips into Louisiana. The disease vector is now a problem in tomato, pepper, and cotton. Research efforts are underway to survey the extent of the problem and evaluate new cultural controls.

Attack of Cercospora needle blight on asparagus in Oklahoma, has necessitated the research effort of a horticultural scientist to find cultural control of the pest. In Tennessee, an entomologist indicates that several pest species have become resistant to insecticides and there is a shift to the use of parasites and predators as a measure of controlling the pest problem. A plant pathologist in California points out that bacterial speck disease of tomato has been controlled for years with copper sprays, but copper resistant strains of the pathogen have now developed and become widespread. Maintenance research is being conducted to develop alternative control methods using biological control agents. Insects - maggot, thrips damage, disease-pink root, and fusarium in onions have occurred in Michigan. Scientists have collected germplasm and studies are underway for insect and disease resistance. In addition, there are efforts to use cultural and biological controls against these insects and diseases.

There is an intensification in the use and search of biological and cultural controls in other crops such as peanuts, cotton, alfalfa, tobacco, corn, and potatoes. A plant pathologist in North Carolina gives examples of increasing problems (current cultivars) with Cylindrocladium black rot and Sclerotinia blight disease in peanut. As a result, host and pathogen genetics and economic studies on utilization of resistance and cultural practices are being conducted. In the case of cotton, a plant pathologist points out that new races of Xanthomonar Malvacearum have appeared in Texas. Researchers anticipated these new races and developed resistant varieties. In addition, biological control is under study to combat these pests.

There are indications in Virginia that there is resistance to heptachlor in the alfalfa weevil. Again, researchers are developing biological and cultural controls to combat this pest. In California, plant pathologists are working on cultural practices to control Sclerotium rolfssii, a major problem in potatoes. Dr. C. E. Reichelderfer, an entomologist in Maryland indicates that there are biological practices to control gypsy moth and ants attacking potatoes.

Examples of maintenance research are also given by animal, and poultry scientists. In Virginia, mastitis is a major problem in dairy cattle. In anticipation of resistance of bacteria to antibiotics in the future, dairy scientist are selecting cattle which are less prone to the parasite. An animal scientist in Connecticut is studying the immune system in cattle to assess immunological approaches to increase resistance to mastitis and mooratal infections. An animal scientist in Wisconsin points out that there has been development of antibiotic resistance by Pastevrella and other respiratory pathogens. There are new strategies (vaccine, use of immunoregulatory agents) to supplant antibiotic treatment. In North Carolina, an animal scientist notes that antiviral vaccines used to prevent viral infections of cattle are no longer effective in reducing shipping fever, a respiratory disease due to viral-bacterial synergism. Research is underway to find solutions to this problem. Two animal scientists in the state of Washington point out that there are efforts to find new vaccines for fascisliasis and cysticercosis in cattle and other livestock since these parasites have become resistant to the old vaccines.

A dairy scientist in Ohio gives an example of increase in environmental mastitis, and the search for ways to control environmental pathogens in anticipation of a reduction in the productivity of cattle. There are research efforts in Illinois and Kansas to improve estrus detection and to improve fertility of repeat-breeding cows. Another major problem in cattle production is that horn flies have become resistant to insecticidal ear tags. A dairy scientist, and an entomologist in Missouri and Kansas are evaluating alternative methods and pesticides to control insecticide resistant populations of horn flies. Dr D.L. Davis, an animal scientist notes that "there is a decline in libibo and mating ability of boars, and research is underway in Kansas to find the causes, and solution to these problems."

It was mentioned in chapter 2 that genetic engineering is farther advanced in livestock production than in crop production. However, only one dairy scientist in Missouri made reference to the use of this new technology to maintain and/or improve on cattle populations that are not susceptible to diseases.

Poultry has experienced diseases as well. A poultry scientist in Oregon points out that poor enclosed broiler house environments (high levels of dust, ammonia, and feathers) tend to reduce broiler performance. However, poultry scientists and agricultural engineers are working on developing ventilation systems, and management systems in enclosed broiler house environments to prevent productivity from declining. In Texas, a poultry scientist notes that early mortality in broilers has just been recognized and research is underway to find causes and solutions to prevent the spread of the disease that causes early mortality in broilers.

A poultry scientist in Georgia gives an example of resistance to anticocccidial by Coccidiosis and other parasites. There are surveys of field isolates for resistant strains, and research is being conducted on strategies for slowing down emergence of resistance. Poor hatchability in turkeys was shown to be caused by hypothyroidism due to selection for heavier weights and improved feed efficiency. Researchers solved the problem by administering exogenous thyroid hormones.

In Pennsylvania, there is an example of kidney damage in poultry caused by an infectious bronchitis virus - possibly by vaccine strains. There is also water consumption problem caused by selection for fast growth. There is on-going research to find solutions to these problems. In Alabama, there are developments of variant or resistant strains of viral, bacterial, and protozoan diseases in poultry as widely used preventive and treatment drugs have become less effective. New drugs have been and are being developed to prevent wide spread decline in productivity of poultry.

Although the focus of the survey was U.S. agricultural scientists, six agricultural scientists give examples of maintenance research in other countries beside the United States. Improved soybean varieties developed in temperate areas can produce high yields in tropical areas. However, seed of these varieties when grown in the tropics is of low quality, necessitating re-imports or loss of materials. An agronomist in Missouri notes that a program at the International Institute of Tropical Agriculture (IITA) in Nigeria stressed selection of genotypes resistant to field weathering and this has resulted in improved soybeans seed under tropical production conditions.

Charcoal rot in grain sorghum resulted in severe losses in South-Central India. Fortunately, resistant germplasm incorporated into new cultivars were effective in controlling further decline in the productivity of sorghum. Again, in India and also in the US, breeders are researching for resistant varieties to combat virus diseases of peanuts which have caused high yield losses the last few years. There are collaborations between Dr. R. A. Taber, a plant pathologist in Texas and researchers at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India to find solution to the virus problem in peanuts.

Finally, Dr. D. P Coyne, a horticultural scientist in Nebraska notes that emergence of new races of rust and halo blight of beans reduced productivity of drybeans in the United States. A new non-specific type of resistance to rust (all races) was detected in the Dominican Republic. This is a source of resistance to halo blight race 2 and is being introduced in bean germplasm in the United States. These examples indicate that maintenance research is being conducted on all the major agricultural commodities in the US, and that some US scientists are working on commodities in other parts of the world. The summary of the statistical and descriptive analyses are combined in a discussion in the next section.

4.3 Discussion of Statistical Results and Descriptive Analysis

The statistical and descriptive analyses of the responses to the scientist questionnaire clearly indicate that maintenance research is an important component of total research in the United States and that most maintenance research is related to insect and disease problems in crops and livestock.

Most of the scientists working on crops indicate that gains to research begin to decline in the fourth or fifth year; animal scientists, on the other hand, did not indicate when they believed deterioration and obsolescence overcome increases in gains to research. Based on limited personal conversation with animal scientists, it appears that gains in research begin to decline in and around the tenth year. In most cases, it takes about ten years or more for scientists to detect bacterial resistance to parasites. The time period for gains to decline, therefore, tends to be shorter in crops than in livestock. This supports the results of this study that more research effort is devoted to maintenance research on crops than on livestock, and poultry. Livestock has the lowest percentage of research effort devoted to maintenance, 21.4 percent. Furthermore, livestock has the highest percentage of the annual research budget but other commodities have a higher percentage of the maintenance research budget than livestock. This is because maintenance research is a smaller component of livestock research than of crop research. There are significant differences between some of the crops on the efforts of research devoted to maintenance research.

These results and discussion are based on the primary data obtained from the responses to the scientist questionnaire. The other procedure used in this study is an econometric model to analyze the impacts of research on agricultural productivity, using secondary data.

4.3 Summary of Chapter

This chapter presented the statistical results of the scientist questionnaire, extrapolation of the results to obtain estimates of total expenditures on agricultural maintenance research on each commodity in the United States, and tested two of the hypotheses in this study. The results indicated that agricultural maintenance research is an important component of the total agricultural research. In addition, the t-test also indicated that there were significant difference in the percentage of research effort devoted to maintenance research among the commodities. Examples of maintenance research given by the scientists responding to the questionnaire were discussed. The analysis of the results of the econometric model is discussed in the next chapter.

While widely and variously used, most distributed lag models have almost no or only a very weak theoretical underpinning. Usually the form of the lag is assumed **a priori** *rather than derived as an implication of a particular behavioral hypothesis.*

Griliches, Z. *Distributed Lags: A Survey* Econometrica, Vol. 35, No.1, January, 1967 (p 42).

Chapter 5

RESULTS AND DISCUSSION OF ECONOMETRIC MODEL

5.1 Introduction

The results of estimating the econometric model used to examine the length and the shape of the research lag by commodity group are presented in this chapter. The results of estimating the input demand and output supply equations are discussed and hypothesis testing is conducted to assess if the restrictions from neoclassical economic theory are met and if research depreciation varies by commodity groups. The impact of agricultural research on agricultural productivity is presented and discussed.

5.2 Results of Estimating the Econometric Model with a Cubic Lag on Research

The results of estimating the output supply and the input demand equations with a cubic lag on research are shown in Tables 5.1a and 5.1b. The coefficients on the research variables exhibit large standard errors and consequently low levels of significance. The most likely explanation for this result is multicollinearity. Variance inflation factors were calculated and are presented in Table 5.3. The VIFs for the three research variables when using the cubic lag are 954.74, 6513.57, and 2719.99. These VIFs are greater than 30 the bench mark used as a guide to detect multicollinearity (see Pindyck and Rubinfeld). The VIFs indicate that there is severe multicollinearity among the three research variables.

Several procedures are available for handling multicollinearity problems (for example, ridge regression, principal components regression, mixed estimation, dropping variables). Application of ridge regression and principal component regression is controversial, especially for system of equations. Consequently, it was decided to use an alternative distributed lag for research which required fewer coefficients to be estimated. It was recognized that this decision meant that the hypothesis that the impact of research increases at an increasing rate, then increases at a decreasing rate, reaches a maximum, and then declines could not be tested. However, this tradeoff was made to improve the confidence in the declining portion of the estimated lag (i.e., the portion that measures research depreciation).

Two distributed lags were explored (the quadratic and inverted-V), but only the results of using the inverted-V with the terminal end-point unconstrained (3.48) are presented in this chapter. When the quadratic lag was included in the estimation, the VIFs for the two research variables were 1390.26 and 1419.79 (See Table 5.4). Again, these VIFs were greater than the bench mark and indicated severe multicollinearity. Consequently, the inverted-V was used. The VIF's which were calculated

5.1a Estimates of Output Supply functions for U.S. Agriculture, 42 states, 1978-1982 with Research Included as a Cubic Distributed Lag[a]

Explanatory Variables	Output Supply Equations					
	Food Grains	Feed Grains	Other Crops	Livestock	Poultry	Hay
Normalized Prices						
Food Grains	.139	-.109	.001	.027	-.063	-.064
	(1.37)	(1.26)	(0.20)	(1.69)	(2.39)	(0.87)
Feed Grains	-.109	.146	-.009	-.020	.055	-.030
	(1.26)	(0.96)	(0.68)	(1.65)	(2.07)	(0.49)
Other Crops	.001	-.009	-.0008	.0004	-.002	.004
	(0.20)	(0.68)	(0.07)	(0.50)	(0.74)	(0.94)
Livestock	.027	-.020	.0004	2.264	-.336	-.061
	(1.69)	(1.65)	(0.50)	(0.84)	(0.12)	(2.46)
Poultry	-.063	.055	-.002	-.336	1.332	.031
	(2.39)	(2.07)	(0.74)	(0.12)	(0.22)	(0.33)
Hay	-.064	-.030	.004	-.061	.031	.317
	(0.87)	(0.49)	(0.94)	(2.46)	(0.33)	(2.31)
Feed	.013	-.018	.001	.003	-.007	-.013
	(1.15)	(0.96)	(0.49)	(1.73)	(1.29)	(1.72)
Fertilizer	.021	-.017	-.0002	-.007	.006	.001
	(2.79)	(2.75)	(0.36)	(1.59)	(0.84)	(1.39)
Fuel	-.002	.0006	-.00004	-.068	.128	-.005
	(3.49)	(1.25)	(1.16)	(0.67)	(1.00)	(0.21)
Labor	.035	.009	-.0003	.059	.017	-.040
	(2.28)	(0.76)	(0.38)	(1.15)	(0.19)	(0.52)
Fixed Factors						
Land	−.0007	0007	.0008	.00009	..0002	−.0009
	(2.17)	(0.97)	(1.31)	(1.88)	(1.24)	(4.21)
Rain	-14.20	36.58	4.22	.52	-1.38	2.98
	(2.47)	(2.68)	(0.37)	(0.62)	(0.48)	(0.71)
Education	.012	.026	.032	-.0007	-.011	.033
	(0.62)	(0.57)	(0.85)	(0.24)	(1.12)	(2.27)
Extension	-.058	-.314	.122	-.006	.031	.078
	(1.16)	(2.92)	(1.40)	(0.78)	(1.28)	(2.14)
Research[b]	-1.30^{-7}	9.20^{-8}	1.06^{-6}	2.12^{-8}	3.99^{-9}	6.36^{-7}
	(0.29)	(0.09)	(1.37)	(0.30)	(0.02)	(1.85)
Research[c]	5.29^{-8}	-5.70^{-8}	-2.53^{-8}	2.52^{-9}	-6.07^{-9}	-2.06^{-7}
	(0.31)	(0.15)	(0.81)	(0.10)	(0.07)	(1.60)
Research[d]	-5.31^{-9}	4.07^{-9}	1.48^{-8}	-7.42^{-10}	4.587^{-10}	1.46^{-8}
	(0.37)	(0.12)	(0.55)	(0.34)	(0.07)	(1.37)
Capital	21.76	52.15	24.97	2.36	2.78	14.00
	(4.35)	(4.84)	(3.02)	(2.75)	(1.09)	(3.95)
Breeding Stock	1.80	-6.20	-2.24	.248	-.938	8.37
	(1.56)	(2.29)	(1.00)	(1.38)	(1.57)	(9.73)
Intercept	-4.12	17.39	-344.34	3.36	85.00	-359.23
	(.03)	(.05)	(1.37)	(.16)	(1.26)	(3.51)

R^2 for the system = 0.8519

[a] t-statistics in parenthesis.
[b] is the α_1 coefficient
[c] is the α_2 coefficient
[d] is the α_3 coefficient

5.1b Estimates of Input Demand functions for U.S. Agriculture, 42 states, 1978-1982 with Research Included as a Cubic Distributed Lag[a]

Explanatory Variables	Input Demand Equations Feed	 Fertilizer	 Fuel	 Labor
Normalized Prices				
Food Grains	-.013	-.021	.002	-.035
	(1.29)	(2.79)	(3.49)	(2.28)
Feed Grains	.018	.017	-.0006	-.009
	(0.97)	(2.75)	(1.25)	(0.76)
Other Crops	-.001	.0002	.00004	.0003
	(0.49)	(0.36)	(1.16)	(0.38)
Livestock	-.003	.007	.068	-.059
	(1.73)	(1.59)	(0.67)	(1.15)
Poultry	.007	-.006	-.128	-.017
	(1.29)	(0.84)	(1.00)	(0.19)
Hay	.040	.013	-.001	.005
	(0.52)	(1.72)	(1.39)	(0.21)
Feed	-.011	-.003	-.0002	.00008
	(2.29)	(2.76)	(2.43)	(0.04)
Fertilizer	-.003	-.008	-.0001	.016
	(2.76)	(3.49)	(0.71)	(3.31)
Fuel	-.0002	-.0001	-.22	-.002
	(2.43)	(0.71)	(4.72)	(0.93)
Labor	.00008	.015	-.002	-.041
	(0.04)	(3.31)	(0.93)	(0.78)
Fixed Factors				
Land	.00005	.00008	.000002	-.0002
	(0.43)	(3.80)	(1.55)	(3.53)
Rain	-2.59	.47	-.016	1.77
	(1.09)	(1.12)	(0.53)	(2.05)
Education	-.009	.0007	.000002	-.006
	(1.12)	(0.51)	(0.02)	(1.84)
Extension	.048	-.0002	-.00005	-.002
	(2.45)	(0.04)	(0.16)	(0.24)
Research[b]	-2.42^{-8}	7.00^{-8}	8.74^{-10}	2.25^{-8}
	(0.44)	(2.73)	(0.72)	(0.16)
Research[c]	3.43^{-9}	-2.21^{-8}	5.13^{-10}	-7.23^{-9}
	(0.05)	(1.71)	(0.53)	(0.27)
Research[d]	-9.16^{-11}	1.66^{-9}	-8.39^{-11}	4.87^{-10}
	(0.02)	(0.21)	(1.50)	(0.50)
Capital	5.04	3.60	.52	5.90
	(2.49)	(8.58)	(15.85)	(6.76)
Breeding Stock	-.56	-.44	.001	.50
	(1.16)	(5.16)	(0.17)	(2.71)
Intercept	71.50	4.88	1.78	158.59
	(1.29)	(.48)	(2.20)	(7.60)
R^2 for the system = 0.8519				

[a] t-statistics in parenthesis.
[b] is α_1 coefficient
[c] is α_2 coefficient
[d] is α_3 coefficient

Table 5.2 Variance Inflation Factors Associated with the Econometric Model with Research Included as a Cubic Distributed Lag

Variables	VIF
NPGRA77	9.45
NPRCROP77	4.06
NPOTH77	2.08
NPLIVE77	2.29
NPPOUL77	2.65
NPHAY77	1.66
NPFEED	3.32
NPFERT	3.36
NPFUEL	6.95
NWAGE	3.51
NSTOCK	15.87
NWLAND	13.97
RAIN	1.14
EDUC	3.13
EXT	2.97
NCAPITAL	5.04
RESEAR11	954.74
RESEAR12	6513.57
RESEAR13	2719.99

Table 5.3 Variance Inflation Factors Associated with the Econometric Model with Research Included as a Quadratic Distributed Lag

Variables	VIF
NPGRA77	3.13
NPRCROP77	3.95
NPOTH77	3.30
NPLIVE77	3.76
NPPOUL77	1.85
NPHAY77	2.66
NPFEED	8.12
NPFERT	6.08
NPFUEL	6.41
NWAGE	7.91
NSTOCK	32.34
NWLAND	20.62
RAIN	2.64
EDUC	3.93
EXT	5.04
NCAPITAL	9.70
RESEAR	1390.26
RESEAR12	1419.79

after the inverted-V distributed lag for research was included in the model are shown in Table 5.4. They indicate that multicollinearity is not a serious problem in the model.

The unconstrained terminal end-point was used with the inverted-V lag so as not to constrain the impact of research to depreciate to zero in a particular year. A statistical search also was conducted to evaluate the optimal lag length to include in the model. The peak year for the impact of agricultural research was allowed to vary from 6 to 9 years in alternative estimations. The 'best' estimate is that the maximum impact occurs in the eighth year; based on the number of correct signs on the coefficients on the research variables and the significance of the research variables. The R^2 values of the single equations OLS estimates are .61 for foodgrains, .55 for feedgrains, .53 for other crops, .83 for livestock, .91 for hay, .38 for poultry, .46 for feed, .80 for fertilizer, .94 for fuel, and .81 for labor. The R^2's of the single equation OLS estimates for the other peak years are in Table 5.5.

The R^2's for the 6-year lag are higher than the 8-year lag but the results of the latter are reported. The signs on the research variables are not as expected in all the other equations except for other crops in the 6-year lag. The sign on the research variables are as expected in the other crops, livestock, and hay equations in the 8-year lag. In addition, the own-price coefficients for feed and fuel are not significant in the 6-year lag but are significant in the 8-year lag.

In the econometric model, ten equations were estimated jointly and a set of thirty-six symmetry restrictions were imposed. A joint F-test of these conditions yielded a F-value of 3.45. Therefore, symmetry could not be rejected at the 5% significance level. The normalized quadratic profit function is therefore adequate for analyzing US agricultural production over the two census years, 1978 and 1982. For the analyses of the results that follow, symmetry is imposed on the system of equations in the estimation process.

Table 5.4 Variance Inflation Factors Associated with the Econometric Model with Research Included as an Inverted-V Lag

Variables	VIF
NPGRA77	9.31
NPRCROP77	4.04
NPOTH77	2.08
NPLIVE77	2.27
NPPOUL77	2.69
NPHAY77	1.66
NPFEED	3.21
NPFERT	3.33
NPFUEL	6.96
NWAGE	3.45
NSTOCK	15.46
NWLAND	13.81
RAIN	1.14
EDUC	3.11
EXT	2.95
NCAPITAL	4.92
SEARCH15	5.67
SEARCH16	4.43

Table 5.5 R^2, F-test, and the Number of Correct Own-Price and Research Variables Signs for the 6-year, 7-year, and 9-year Lags

	6th year	7th year	9th year
Food Grains	.89	.61	.61
Feed Grains	.87	.56	.55
Other Crops	.67	.53	.53
Livestock	.91	.83	.83
Poultry	.63	.38	.38
Hay	.94	.91	.91
Feed	.66	.46	.46
Fertilizer	.88	.80	.80
Fuel	.96	.94	.93
Labor	.89	.81	.81
NCOP[a]	9	9	9
NCRA[b]	2	4	4
R^2[c]	.92	.83	.84

[a] is the number of correct own-price signs.

[b] is the number of correct research variables signs.

[c] This is the R^2 that corresponds to the approximate F-test on all the parameters in the system.

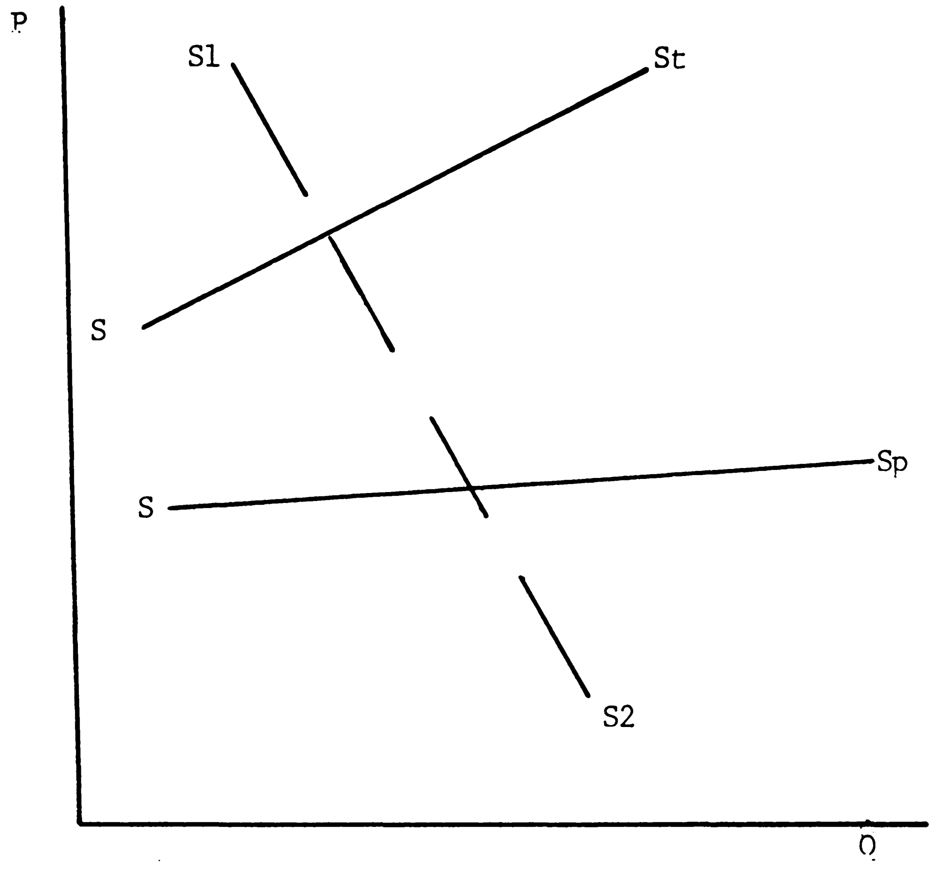
5.3 Estimates of the Output Supply and Input Demand Equations with an Inverted-V Lag on Research

5.3.1 Introduction

Estimates of the six output supply (foodgrains, feedgrains, other crops, poultry, livestock, and hay) and four input demand (feed, fertilizer, fuel, and labor) equations estimated jointly using data for forty-two U.S. states pooled over agricultural census years 1978 and 1982 are presented in Tables 5.6 and 5.7. Because the data are pooled over two agricultural census years, the number of pooled observations are eighty-four.

5.3.2 Estimates of Output Supply Equations

The results of the output supply equations are presented in this section of the thesis. All own-price coefficients have the expected signs except for other crops. Other crops includes thirteen different commodities, hence, it is possible that there are interactions between these commodities that generate the wrong sign. More importantly, two identified commodities included in this category that exhibit interactions which might lead to a wrong sign are tobacco, and potatoes. Tobacco is a low-volume high-priced commodity while potato is a high-volume low-priced commodity. Consequently, aggregating these two commodities, potentially, generates a downward sloping supply curve. This point is illustrated by using figure 5.1. The line SS_T represents the curve of the low-volume high-priced commodity (tobacco), and the line SS_P is the supply curve of the high-volume low-priced commodity (potato). Aggregating observation for these two commodities might generate the curve S_1S_2. The interaction between the prices and the quantities of these commodities pull in different directions resulting in a downward sloping supply curve. This interaction between the



where: P is the price of tobacco and potatoes
Q is the quantity of tobacco and potatoes

Figure 2. Aggregating the Supply of High-Volume Low-Price Commodity and Low-Volume High-Price Commodity.

prices and quantities of tobacco and potatoes, and similar interactions between the other commodities could, potentially, be the reason for the negative sign on the own-price coefficient of other crops.

The own-price coefficients of the outputs are not significant at the 5% level except for hay (Table 5.6). The own-price coefficient of hay is .337. The results indicate that the estimated coefficients on cross-prices also exhibit low levels of significance. The significant ones are the feedgrains and poultry cross-price coefficient in the feedgrain equation, and the hay and livestock cross-price coefficient in the hay equation. The coefficient on the feedgrains and poultry variable is .056 and the coefficient on the hay and livestock variable is -.059. These coefficients indicate that feedgrains and poultry are substitutes and hay and livestock are complements. Some of the inputs have significant effects on the outputs; feed has no significiant effect on any of the outputs. Fertilizer has a significant and negative effect on foodgrains. This is contrary to expectations since increases in the price of fertilizer is expected to reduce the quantity supplied of foodgrains.

Fuel has a significant effect on only one output - foodgrains. A higher fuel price reduces the supply of foodgrains as expected. The price of labor has a significant and positive effect on foodgrains. This effect is contrary to expectations since an increase in the cost of labor is expected to reduce the supply of foodgrains.

The fixed factors also have significant effects on the quantities supplied of these commodities. Capital is significant and positively affects all the commodities except for poultry. Land, on the other hand, has a negative and significant effect on foodgrains and hay. Rain (deviation from normal July rainfall) has a negative and significant effect on foodgrains but a positive and significant effect on feedgrains. The effect of rain on foodgrains is contrary to expectation since increases in rain is expected to be associated with increases in the quantity supplied of foodgrains. Education has a positive and significant effect on hay but it is not significant on all the other commodities. Extension has a positive and significant effect on poultry and hay, and a negative and significant effect

Table 5.6 Estimates of Output Supply functions for U.S. Agriculture, 42 states, 1978-1982 with Research as an Inverted-V Distributed Lag[a]

Explanatory Variables	Output Supply Equations Food Grains	Feed Grains	Other Crops	Live-stock	Poultry	Hay	Milk
Normalized Prices							
Food Grains	.129	-.102	.0009	.025	-.061*	-.057	-.920
	(1.27)	(1.20)	(0.57)	(1.53)	(2.32)	(0.77)	
Feed Grains	-.102	.146	-.010	-.021	.056*	-.029	-.972
	(1.20)	(0.97)	(0.72)	(1.72)	(2.13)	(0.47)	
Other Crops	.0009	-.010	-.0006	.0005	-.002	.004	.014
	(0.15)	(0.72)	(0.05)	(0.55)	(0.76)	(0.91)	
Livestock	.025	-.021	.0005	1.709	-.929	-.059*	-5.269
	(1.53)	(1.72)	(0.55)	(0.62)	(0.32)	(2.40)	
Poultry	-.061*	.056*	-.002	-.929	1.293	.038	-1.163
	(2.32)	(2.12)	(0.76)	(0.32)	(0.21)	(0.41)	
Hay	-.057	-.029	.004	-.059*	.038	.337*	1.291
	(0.77)	(0.47)	(0.91)	(2.40)	(0.41)	(2.47)	
Feed	.011	-.018	.001	.003	-.008	-.012	-.002
	(0.97)	(1.00)	(0.51)	(1.43)	(1.34)	(1.62)	
Fertilizer	.021*	-.016*	-.0002	-.008	.006	.001	.436
	(2.74)	(2.68)	(0.40)	(1.94)	(0.84)	(1.08)	
Fuel	-.002*	.0005	-.00003	-.027	.104	-.005	-1.730
	(3.17)	(1.07)	(1.00)	(0.24)	(0.75)	(0.20)	
Labor	.035*	.009	-.0003	.066	.016	-.043	-1.350
	(2.28)	(0.77)	(0.36)	(1.28)	(0.19)	(0.57)	
Milk	-.920	-.972	.014	-5.269	-1.163	1.29	-69.99
Fixed Factors							
Land	−.0007*	0007	.0008	.00008	.0002	−.0009*	−.006
	(2.21)	(0.98)	(1.29)	(1.77)	(1.24)	(4.24)	(.25)
Rain	−14.17*	36.59**	4.55	.0620	−1.402	3.066*	−535.20
	(2.45)	(2.69)	(0.40)	(0.74)	(0.49)	(0.73)	(1.13)
Education	−.014	.024	.030	−.001	.011	.032*	1.71
	(0.70)	(0.53)	(0.83)	(0.34)	(1.13)	(2.23)	(1.24)
Extension	−.066	−.319	.127	−.008	.029*	.076*	−4.72
	(1.33)	(3.00)	(1.02)	(1.22)	(2.10)	(2.10)	(1.32)
Research[b]	-2.20^{-8}	-2.56^{-8}	1.42^{-7}	6.29^{-9}	-7.06^{-9}	4.63^{-8}	-2.0^{-6}
	(0.59)	(0.32)	(2.36)	(1.06)	(0.40)	(1.62)	(.83)
Research[c]	8.13^{-8}	1.60^{-7}	4.37^{-8}	1.88^{-8}	1.98^{-8}	1.12^{-7}	-1.5^{-5}*
	(1.10)	(0.94)	(0.33)	(1.66)	(0.55)	(2.03)	(2.79)
Capital	21.81*	51.50*	25.35*	2.62*	2.74	13.61*	12.78
	(4.39)	(4.83)	(3.11)	(3.07)	(1.09)	(3.88)	(.04)
Breeding Stock	1.92	−6.12*	−2.21	.29	−.91	8.41*	−20.54
	(1.67)	(2.27)	(0.99)	(1.60)	(1.56)	(9.86)	(.23)
Intercept	8.75	29.75	-340.43	9.94	85.75	-361.75*	8224.48
	(.06)	(.09)	(1.37)	(.48)	(1.29)	(3.57)	(.96)

R^2 for the system = 0.8360

[a] t-statistics in parenthesis.
[b] d coefficient on inverted-V distributed lag.
[c] f coefficient on inverted-V distributed lag.
* Significant at the 5% level.

on feedgrains. Breeding stock of animals, has a significant and negative effect on feedgrains, and a positive and significant effect on hay.

The coefficient of the increasing section (d) of the research lag is negative on foodgrains, feedgrains, and poultry, and positive on other crops, livestock, and hay. However, only the coefficient on the research variable in the other crops equation is significant at the 5% level. The coefficient of the decreasing section (f) of the research lag is positive on all the output supply equations. Only the coefficient on the research variable in the hay equation is significant at the 5% level. From equation 3.48, the coefficients on the increasing and the decreasing sections of the research variables are expected to be positive. This implies that the sign on the coefficients of the research variable in the other crops and the hay equations are as expected. The impacts of agricultural research on agricultural output are calculated by using equations 3.43 and 3.47, the results are reported in Tables 5.10 and 5.11, which are presented and discussed later in section 5.3.6.

5.3.3 Estimates of Input Demand Equations

The estimates of the input demand functions are presented in Table 5.7. The results indicate that the coefficient on all the own-prices have the expected (negative) sign and are all significant except for labor. Most of the effects of the fixed factors on the input prices are not significant except for capital and land. Capital is strongly and positively related to the demand for all the inputs. Increasing capital by one unit significantly increases the quantities demanded for all the inputs. Land is positively related to all the inputs except for labor. This implies that increasing the quantity of land significantly reduces the quantity demanded of labor. One possible explanation for this would be that as more land is brought under cultivation, labor is substituted for by machinery. Land is positively and significantly related to fertilizer as expected.

Table 5.7 Estimates of Input Demand functions for U.S. Agriculture, 42 states, 1978-1982 with Research as an Inverted-V Distributed Lag[a]

Explanatory Variables	Input Demand Equations Feed	 Fertilizer	 Fuel	 Labor
Normalized Prices				
Food Grains	-.011	-.020*	.002*	-.035*
	(0.97)	(2.74)	(3.17)	(2.28)
Feed Grains	.018	.016*	-.0005	-.009
	(1.00)	(2.68)	(1.07)	(0.77)
Other Crops	-.001	.0002	.00003	.0003
	(0.51)	(0.40)	(1.00)	(0.36)
Livestock	-.003	.008	.027	-.066
	(1.43)	(1.94)	(0.24)	(1.28)
Poultry	.008	-.006	-.104	-.016
	(1.34)	(0.84)	(0.75)	(0.19)
Hay	.043	.012	-.001	.005
	(0.57)	(1.62)	(1.08)	(0.20)
Feed	-.011*	-.002*	-.0002*	.00007
	(2.30)	(2.54)	(2.86)	(0.04)
Fertilizer	-.002*	-.008*	-.0002	.016*
	(2.54)	(3.31)	(1.02)	(3.38)
Fuel	-.0002*	-.0002	-.22*	-.002
	(2.86)	(1.02)	(4.46)	(0.94)
Labor	.00007	.016*	-.002	-.039
	(0.04)	(3.38)	(0.94)	(0.76)
Milk	.002	-.436	1.730	1.350
Fixed Factors				
Land	.00005	.00008*	.000002	-.0002*
	(0.43)	(3.80)	(1.33)	(3.54)
Rain	-2.62	.48	-.016	1.76*
	(1.10)	(1.13)	(0.49)	(2.05)
Education	-.009	.0008	-.00002	-.006
	(1.13)	(0.54)	(0.15)	(1.88)
Extension	.048*	.0008	-.0002	-.002
	(2.47)	(0.20)	(0.75)	(0.27)
Research[b]	-6.22^{-9}	7.85^{-9}	1.73^{-10}	9.49^{-10}
	(0.44)	(2.73)	(0.72)	(0.16)
Research[c]	4.94^{-10}	1.20^{-9}	6.94^{-10}	5.79^{-9}
	(0.02)	(0.21)	(1.50)	(0.50)
Capital	4.96*	3.56*	.53*	5.85*
	(2.48)	(8.50)	(15.35)	(6.80)
Breeding Stock	-.56	-.45*	.004	.51*
	(1.17)	(5.24)	(0.49)	(2.75)
Intercept	69.81	3.87	2.10*	158.89*
	(1.28)	(.38)	(2.47)	(7.70)

R^2 for the system = 0.8360

[a] t-statistics in parenthesis.

[b] d coefficient on inverted-V distributed lag.

[c] f coefficient on inverted-V distributed lag.

* Significant at the 5% level.

Rain has a positive and significant effect on only labor. Education has no significant effect on any of the inputs. Extension has a positive and significant effect on feed. Breeding stock has a negative and significant effect on the quantity demanded for feed, and a positive and significant effect on the quantity demanded for hay. The coefficient of the increasing section (d) of the research lag is significant and positive, as expected, in the fertilizer equation. The coefficient of the increasing section of the research lag in the fuel and labor equations are positive and non-significant. The coefficient of the increasing section of the research lag is negative in the feed equation and also non-significant. The coefficient of the decreasing section of the research lag are positive in all the input demand equations and non-significant.

5.3.4 Estimates of Output Supply Elasticities

The output supply elasticities, evaluated at the sample mean are reported in Table 5.8. All the own-price elasticities have the expected sign (positive) except other crops. The own-price supply elasticities for foodgrains, feedgrains, other crops, livestock, poultry and hay, respectively are: .790, .319, -.005, .221, .182, and .565. These are relatively small (inelastic) except for foodgrains. Weaver obtained a comparable output supply elasticity (.789) for foodgrains. However, Weaver's estimated elasticities on feedgrains (.638) and livestock (1.011) are substantially different from the estimated elasticities in this study. Shumway, using disaggregated product supply and input demand, obtained elasticities which also differ from the output supply elasticities in this study. Shumway's estimates are: cotton .25, sorghum .62, wheat .43, corn .07, rice .72, and hay .10. Huffman and Evenson obtained a higher (2.25) output supply elasticity for foodgrains. The estimates in this study imply that the own-price elasticities of output supply are generally more inelastic than these other studies. However, most elasticities in the current study are non-significant at the 5% level.

The cross-price elasticities are also relatively small except for foodgrains and poultry, and feedgrains and poultry which are -1.405 and 1.331 respectively. Foodgrains and poultry are complements,

Table 5.8 Output Supply Elasticities for U.S. Agriculture, 42 states, 1978-1982.

	Elasticity with respect to normalized price of:									
Output:	Foodgrains	Feedgrains	Othercrops	Livestock	Poultry	Hay	Feed	Fertilizer	Fuel	Labor
Food Grains	.790	-.645	.017	.001	-.002*	-.205	.320	.392*	-.0002*	.109*
Feed Grains	-.216	.319	-.065	-.0004	.0007*	-.036	-.181	-.107*	.00002	.01
Other Crops	.003	-.031	-.005	.00001	-.00004	.007	.014	-.002	-.000001	.005
Livestock	.390	-.339	.024	.221	-.089	-.542*	.223	-.380	-.006	.532
Poultry	-1.405*	1.331*	-.140	-.117	.182	.515	-.108	.052	.005	.024
Hay	-.162	-.085	.035	-.001*	.0007	.565*	-1.314	.070	-1.750	-.511

* Significant at the 5% level.

and feedgrains and poultry are substitutes and are elastic. The cross-price elasticities among the other outputs are negative, impling that they are all complements, except for foodgrains and other crops, other crops and livestock, other crops and hay, and poultry and hay.

Increases in the prices of the inputs have diverse effects on the supply of outputs. A percentage increase in the price of fertilizer increases the quantity supplied of foodgrains by .392%, and reduces the quantity supplied of feedgrains by .107%. The relationship between fertilizer and foodgrains is contrary to expectations since increases in the price of fertilizer is expected to reduce the quantity supplied of foodgrains. A one percent increase in the price of fuel decreases the quantity supplied of foodgrains by .0002% as expected. When the wage rate increases, it is surprising that the quantity supplied of foodgrains increases. A one percent increase in the wage rate increases the quantity supplied of foodgrains by .109%. The other elasticities were not significant at the 5% level.

5.3.5 Estimates of Input Demand Elasticities

The input demand elasticities are reported in Table 5.9. All the own-price elasticities are negative, as expected. However, the own-price elasticities are inelastic. The implied price elasticity of demand for feed is -.660, fertilizer is -.514, fuel is -.453, and labor is -.056. Huffman and Evenson obtained similar elasticities in their study except for labor where they obtained

The cross-price elasticities are negative except for feed and labor, and fertilizer and labor. This means that feed and fertilizer, feed and fuel are complements. However, fertilizer and labor are substitutes. Increasing the price of feed by one percent reduces the quantities demanded of fertilizer and fuel by .201% and .126% respectively. When the price of fertilizer increases by one percent, the quantity demanded for feed decreases by .084% and the quantity demanded for labor increases by .136%. A percentage increase in the price of fuel reduces the quantity demanded for feed by

Table 5.9 Input Demand Elasticities for U.S. Agriculture, 42 states, 1978-1982.

	Elasticity with respect to normalized price of:									
Input:	Foodgrains	Feedgrains	Othercrops	Livestock	Poultry	Hay	Feed	Fertilizer	Fuel	Labor
Feed	-.153	.258	-.042	-.0003	.0007	.098	-.660*	-.084*	-.00004*	.005
Fertilizer	-.443*	.348*	.013	.001	-.0008	-.012	-.201*	-.514*	-.0006	.174*
Fuel	.245*	-.068	.012	.003	-.084	.389	-.126*	-.081	-.453*	-137
Labor	-.097*	-.026	.003	-.002	-.0003	.070	.0009	.136*	-.00008	-.056

* Significant at the 5% level.

.00004%. Increasing the price of labor by one percent increases the quantity demanded for fertilizer by .174%.

The cross-price elasticities between the prices of outputs and the demand for inputs are also diverse. When the price of foodgrains is increased by one percent, the quantity demanded for fertilizer decreases by .443%, and the quantity demanded for labor decreases by .097%; but the quantity demanded of fuel increases by .245%. A percentage increase in the price of feedgrains increases the quantity demanded for fertilizer by .348%. Each of the elasticities discussed in this section were significant at the 5% level, but the remaining elasticities were not.

5.3.6 Calculated Values of the Impacts of Agricultural Research on Agricultural Outputs and Inputs

As indicated earlier, equations 3.43 and 3.47 are used to calculate the impacts of agricultural research on agricultural output, and the results are reported in Tables 5.10 and 5.11. The results of the calculations indicate that over the ten year period, research has had negative but non-significant (at the 5% level) effects on foodgrains, feedgrains, and poultry output. The impacts of agricultural research on agricultural output are positive and non-significant on livestock. The impacts of research are positive and significant at the 5% level on other crops and hay. For these commodities, the greatest impact of agricultural research on agricultural output occurs in the eighth year.

The impacts of research are positive and non-significant on fuel and labor, but the impacts of research on feed are negative and non-significant. The impacts of research on fertilizer are positive and significant at the 5% level. The effects of agricultural research on fertilizer has the greatest impact in the eighth year.

Maintenance research is related to the impacts of agricultural research on agricultural output. The height of the inverted-V indicates the point where productivity begins to decline. In this study, this

Table 5.10 Impacts of Agricultural Research on Agricultural Commodities for U.S. Agriculture, 42 states, 1978-1982.

Impact:	Foodgrains	Feedgrains	Othercrops	Livestock	Hay	Poultry
1st period	-2.20^{-8}	-2.56^{-8}	1.42^{-7}	6.29^{-9}	4.63^{-8}	-0.7^{-9}
2nd period	-4.41^{-8}	-5.12^{-8}	2.84^{-7}	1.26^{-8}	9.27^{-8}	-1.4^{-8}
3rd period	-6.61^{-8}	-7.25^{-8}	4.26^{-7}	1.87^{-8}	1.29^{-7}	-2.16^{-8}
4th period	-8.82^{-8}	-1.02^{-7}	5.68^{-7}	2.52^{-8}	1.85^{-7}	-2.82^{-8}
5th period	-1.10^{-7}	-1.28^{-7}	7.10^{-7}	3.15^{-8}	2.32^{-7}	-3.53^{-8}
6th period	-1.32^{-7}	-1.54^{-7}	8.53^{-7}	3.77^{-8}	2.78^{-7}	-4.23^{-8}
7th period	-1.54^{-7}	-1.79^{-7}	9.95^{-5}	4.40^{-8}	3.24^{-7}	-4.94^{-8}
8th period	-1.76^{-7}	-2.05^{-7}	1.14^{-5}	5.71^{-8}	3.71^{-7}	-5.64^{-8}
9th period	-2.58^{-7}	-3.64^{-7}	1.09^{-5}	3.15^{-8}	2.59^{-7}	-7.63^{-8}
10th period	-3.39^{-7}	-5.24^{-7}	1.05^{-5}	1.27^{-8}	1.47^{-7}	-9.6^{-8}

Table 5.11 Impacts of Agricultural Research on Agricultural Inputs for U.S. Agriculture, 42 states, 1978-1982.

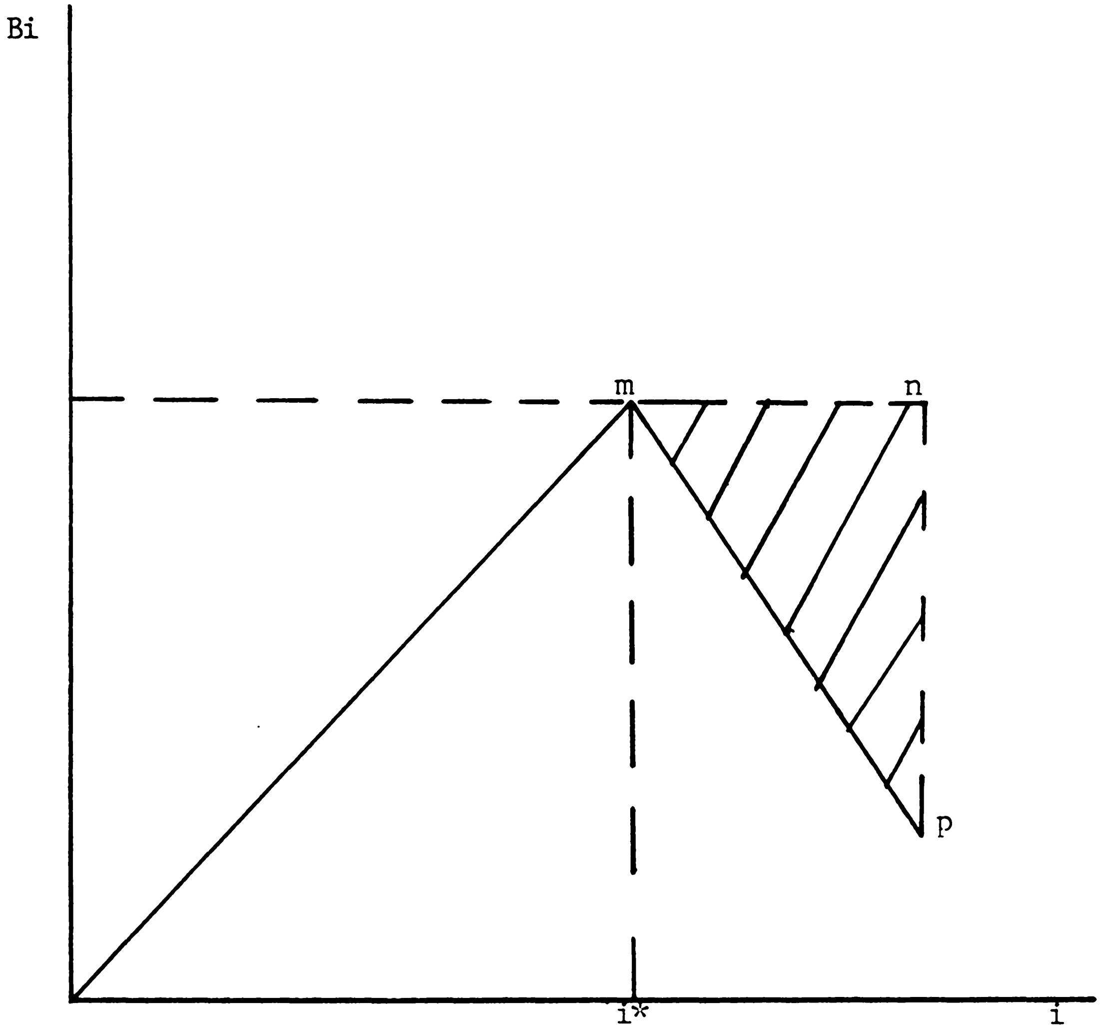
Impact:	Feed	Fertilizer	Fuel	Labor
1st period	-6.22^{-9}	7.85^{-9}	1.73^{-10}	9.49^{-10}
2nd period	-1.24^{-8}	1.57^{-8}	3.46^{-10}	1.90^{-9}
3rd period	-1.86^{-8}	2.36^{-8}	5.19^{-10}	2.84^{-9}
4th period	-2.49^{-8}	3.14^{-8}	6.92^{-10}	3.80^{-9}
5th period	-3.11^{-8}	3.93^{-8}	8.65^{-10}	4.74^{-9}
6th period	-3.73^{-8}	4.71^{-8}	1.04^{-9}	5.70^{-9}
7th period	-4.35^{-8}	5.50^{-8}	1.21^{-9}	6.65^{-9}
8th period	-4.98^{-8}	6.28^{-8}	1.38^{-9}	7.60^{-9}
9th period	-5.03^{-8}	6.16^{-8}	6.89^{-10}	1.81^{-9}
10th period	-5.08^{-8}	6.04^{-8}	-4.30^{-12}	-3.9^{-9}

decline occurs in the eighth year, as indicated earlier in this chapter. The research conducted to maintain productivity at the peak of the lag is termed maintenance research. This need for maintenance research is illustrated by using figure 5.2. The solid line traces out the inverted-V that is estimated by embedding the research variable in the econometric model. The shaded area (mnp) approximates the maintenance research that would be required to keep productivity from declining. The results from the econometric model indicate that the hay equation is the only equation that has a significant depreciation in research. The coefficient of the declining section of the research variable in the hay equation is 1.12^{-7} and it is significant at the 5 percent level. There is also research depreciation in the other equation although they are not significant. The declining section of the research variable in the other equations are: foodgrains 8.13^{-8}, feedgrains 1.60^{-7}, othercrops 4.37^{-8}, livestock 1.88^{-8}, poultry 1.98^{-8}, and milk 6.74^{-9}. The results indicate that milk has the steepest declining slope among the commodities.

The results of the scientist questionnaire indicate that, on the average, maintenance research is 34.8 percent of the total research effort devoted to agriculture in the U.S. Differences in research depreciation for the six commodity groups used in the econometric model are tested by assessing the differences in the slope of the line mp.

5.4 Hypothesis Testing

One hypothesis of this study is that the importance of maintenance research as a proportion of total research varies substantially by commodity groups. The tests conducted in the previous chapter indicated that while maintenance research varies significantly among the individual commodities, the differences in maintenance research among the commodity groups are not significant except for livestock. In this section, using the results of the econometric model, we test for differences in research depreciation by commodity groups.



where Bi is the impact of research
i is time

Figure 3. Measuring Maintenance Research.

Figure 5.2 was used to illustrate agricultural research depreciation. The same figure can be employed to illustrate agricultural research depreciation for each commodity group. Let the area mnp (figure 5.2) represent the research depreciation for each commodity group. Since the peak for each commodity group is the eighth year, differences in research depreciation can be captured by differences in the slope of the line mp. The slope of mp can be measured by the impact of research when the impact is declining. From equation 5.7, the slope of mp is measured by f, which is the coefficient of the lagged research variable when the impact of research is declining. The test to be conducted to ascertain whether research depreciation differs by commodity groups, therefore, is a t-test of the differences between the coefficients of the research variables when the impact of research is declining.

The null and alternative hypotheses are:

$$H_0: \qquad \beta_i = \beta_j \qquad i \neq j \tag{5.1}$$

$$H_A: \qquad \beta_i \neq \beta_j \qquad i \neq j \tag{5.2}$$

where β_i and β_j are the coefficients of the research variable when the impact of research is declining for commodity groups i and j respectively. The null hypothesis, equation 5.27, is that there are no differences between the coefficients of the research variable when the impact of research is declining. The alternative hypothesis, equation 5.28, is that there are differences in the coefficients of the research variable when the impact of research is declining. This is a test of differences between two coefficients and a t-test is constructed as follows:

$$\frac{\beta_i - \beta_j}{S_{\beta i} - S_{\beta j}}$$

where all variables are as defined above, and $S_{\beta i}$ and $S_{\beta j}$ are the standard errors of the coefficients of β_i and β_j , respectively.

The results of this test are reported in Table 5.12. The results indicate that there are significant differences (at the 5% level) in research depreciation between foodgrains and other crops, feedgrains and other crops, other crops and hay, livestock and hay, and hay and poultry. These results suggest that the importance of research depreciation varies substantially for these commodity groups; however, the null hypothesis cannot be rejected for the differences in research depreciation for the other groups.

The results of the t-test using the results of the econometric model are contrary to the results of the t-tests using the results of the survey in some respects. While the results of the survey suggest that there are no differences in maintenance research for the commodity groups except for livestock, the results of the econometric model suggest that there are differences in research depreciation between some of the commodity groups. However, it must be remembered also that the survey results did show significant differences in maintenance research for individual commodities and that these differences were obscured by the grouping. The conclusion from these results is that the importance of maintenance research as a proportion of total research varies substantially for some of the commodity groups but not all the commodity groups.

Table 5.12 Test of Difference Between the Coefficients of the Research Variable when the Impact of Research is Declining.

Commodity Group Comparison	Difference Between Coefficients of Research Variable
Foodgrains-Feedgrains	-1.2^{-7}
Foodgrains-Other Crops	4^{-8}
Foodgrains-Livestock	6^{-8}
Foodgrains-Hay	-2^{-8}
Foodgrains-Poultry	6^{-8}
Feedgrains-Other Crops	1.6^{-7}*
Feedgrains-Live	1.8^{-7}
Feedgrains-Hay	1^{-7}
Feedgrains-Poultry	1.8^{-7}
Other Crops-Live	2^{-8}
Other Crops-Hay	6^{-8}*
Other Crops-Poultry	2^{-8}
Livestock-Hay	8^{-8}*
Livestock-Poultry	.0000**
Hay-Poultry	8^{-8}*

*Difference between coefficients are significant at the 5% level.

** Less than .0000000005.

Chapter 6

SUMMARY AND CONCLUSIONS

6.1 Introduction

This chapter summarizes the key points in the dissertation and presents conclusions and implications based on the results of the scientist survey and the econometric model. Finally, some suggestions for future research are discussed.

6.2 Summary of the Dissertation

The major purpose of this study has been to assess the importance of agricultural maintenance research in the United States. The returns to agricultural research frequently have been assessed using index number and production function approaches. However, these assessments have examined the contribution (yield increasing) of agricultural research to agricultural productivity without specifically considering agricultural maintenance research even though scientists recognize its importance.

Two specific objectives of the study were to examine the relative importance of maintenance research in relation to total agricultural research, and to examine the shape of the lag of the impact of agricultural research on agricultural output. Three hypotheses were put forward: that maintenance research is an important component of total agricultural research in the United States, that the importance of maintenance research as a proportion of total agricultural research varies substantially by commodity groups, and that the shape of the impact of agricultural research on agricultural output increases at an increasing rate, then at a decreasing rate, reaches a maximum, and then declines.

Two procedures were used to address the objectives and the hypotheses of this study. First, a scientist questionnaire was mailed to agricultural scientists throughout the United States. In the questionnaire, scientists were asked which commodities they are conducting research on, to provide examples of research depreciation and maintenance research, and the percentage of their research funds devoted to maintenance research. The responses to these questions were used to address the objectives and the first two hypotheses. The second procedure was an econometric model, using the profit function approach to estimate the shape of the lag of agricultural research and to test the third hypothesis.

The literature review emphasized the conceptual issues involved in agricultural research and the importance of agricultural maintenance research. Four major principles in maintenance research were discussed; then examples of maintenance research in the United States and other parts of the world were presented. Next, the conceptual issues underlying the lag structure of the impact of agricultural research on agricultural output was discussed. Then, examples of previous empirical studies of maintenance research and lagged research impacts were presented.

In chapter 3, the two procedures used in this dissertation were presented in detail. The structure of the scientist questionnaire, various distributed lags, and the profit function were discussed. The econometric model, embedding the research lag in the profit function, were also discussed. The data and the construction of the variables concluded chapter 3.

The results of the scientist questionnaire were presented in chapter 4. The results indicated that agricultural maintenance research is roughly one-third of total agricultural production research in the United States. The results indicated also that barley has the highest percentage of research effort devoted to maintenance research, 42.2%, and livestock has the lowest, 21.4%. In addition, there were significant differences between the percentage of research effort devoted to maintenance research among the commodities. Examples given by scientists point out that agricultural maintenance research is an important component of the total agricultural research.

The results of the econometric model were reported in chapter 5. We were not able to test the hypothesized shape of the impact of agricultural research on agricultural output directly by using the third-order polynomial because of problems with multicollinearity. Consequently, we approximated the lag using an inverted-V distributed lag. The signs on the coefficients of the input demand and output supply equations in most cases, were as expected. However, contrary to expectation, the impacts of agricultural research on foodgrains, feedgrains, and poultry were negative although the coefficients used to estimates the impacts were not significant at the 5% level. The results indicated that there were significant differences between the magnitude of maintenance research for some of the commodity groups.

6.3 Conclusions and Implications of the Results of the Scientist Questionnaire and the Econometric Model

There have been and still are intensive debates on a series of issues relating to the funding of agricultural research in the United States. Representative George Brown points out that "Agricultural research is going through a mid-life crisis. We've emphasized applying existing knowledge and failed to replenish our intellectual capital." (Budlansky).

The results from the questionnaire portion of this study indicated that maintenance research is an important component of total research. This implies that if funding of agricultural research is reduced, not only would agricultural productivity not increase, it would decline.

One of the major conclusions from the results presented in chapter 4 was that agricultural maintenance research in the United States is roughly a third of total research. Another conclusion that may be drawn from the results of the scientist questionnaire is that there are significant differences in maintenance research among the individual commodities.

The results in chapter 5 indicated that the impact of agricultural research on agricultural output in the United States rises and then declines. However, the hypothesis that the impact of research increases at an increasing rate, then at a decreasing rate, reaches a maximum, and then declines could not be test since the cubic lag exhibited very high multicollinearity. In this study, the peak of the impact of agricultural research (using the inverted-V distributed lag) on agricultural output occured in the eighth year. The conclusion is that, over time, deterioration and obsolescence overcome gains in research requiring maintenance research, at least for some commodity groups, to prevent productivity from declining. Another conclusion from estimating the econometric model is that there are significant differences in research depreciation for some of the commodity groups.

6.4 Limitations of the Study

There are a number of limitations to this study. First, the research lag may be different for the various commodity groups but the research lag was not varied for each commodity group.

Another limitation of this dissertation is that only two census years are used in the econometric model. This restricts the possibility of exploring other lag structures such as the rational lag. In addition, it is difficult to capture the impact of agricultural research over ten years with output data for two agricultural census years. If time and resources had permitted, it would have been helpful to use additional time series and cross sectional data for this study.

It was mentioned in chapter 3 that other miscellaneous variables (pesticides, private research, and spillover research) were left out of the analyses. The omission of these variables could, potentially, bias the estimated coefficients if they are correlated with the variables included in the analyses. If the omitted variables are positively correlated with the included variables, then the bias is upward.

On the other hand, the bias is downward if the included and the omitted variables are negatively correlated. The omitted variables are likely to be positively correlated with the research variable included in this study. Hence, the estimated coefficients on the research variable are likely to be biased upward.

There are other econometric limitations besides specification error in this study. First, because of multicollinearity, an inverted-V instead of a cubic lag is used in the estimation of the output supply and input demand equations. As a result, the hypothesis that the impact of agricultural research on agricultural productivity increases at an increasing rate, then at a decreasing rate, reaches a maximum, and then declines could not be tested. Second, there is the problem of aggregation bias. If inputs are used in fixed proportions and/or inputs and outputs are perfect substitutes, then aggregation is not a problem in the estimation procedure. However, sunflower, sugarcane, sugarbeets, oranges, grapefruit, potatoes, cotton, tobacco, peanuts, vegetables, apples, grapes, and peaches which were aggregated as other crops are not perfect substitutes. Gasoline, gasohol, diesel fuel, liquid fuel, butane, propane, and kerosene were also aggregated as fuel. These inputs are hardly used in fixed proportions and are not perfect substitutes. Aggregating these outputs and inputs could, potentially, bias the estimated elasticities of these variables.

Finally, there was no follow-up to see if non-respondents to the survey may be doing less or more maintenance research than respondents. However, the results from the survey are likely to represent an upper bound on maintenance research because the non-respondents may have been doing less maintenance research than the respondents.

6.5 Suggestions for Future Research

Suggestions for future research concentrate on the research variable. Private research expenditures were not included in this study. Other studies assumed that public and private reserach were perfectly positively correlated and as such various adjustments have been made to the public research variable. These adjustments range from giving public and private research equal weights (Griliches 1964) to a weighting scheme which favored public research (Evenson 1968). However, Bonnen has pointed out that two-thirds of all agricultural R&D expenditures are now accounted for by the private sector. These adjustments and observation by Bonnen indicate the relative importance of private agricultural research to total agricultural research. Estimates of the expenditures of private agricultural research should be included in future studies if and when the data allow it.

Previous studies, Davis, and White and Havlicek, indicated that there were spillover effects of agricultural research between the states. These effects have considerable policy implications on investing in agricultural research. It is, therefore, necessary to assess the impact of spillover effects in the future. This assessment would have some impact on the policy decision (federal and state level) on the allocation of research funds to agriculture.

Another suggestion for future research is that additional work is needed on estimating the ″appropriate″ lag structure of the impact of agricultural research on agricultural output. In most studies, including this dissertation, approximations rather than the hypothesized shape of the lag have been estimated. Probably, one distributed lag that needs considerable attention is the rational lag. This lag has the desirable property of allowing the data to ″speak″ for themselves thereby capturing the true shape of the lag. The rational lag was not used in this thesis because it requires additional time-series data.

Research in state agricultural research stations creates education; for example, graduate students working on projects with professors. However, the manner in which the research variable is measured does not capture the full effect of education. Future studies could find a way of measuring the research and/or the education variables to capture this effect.

Finally, a study might be conducted to assess whether the magnitude and importance of agricultural maintenance research in the United States has become relatively more important over time or not.

One may then test the hypothesis put forward by Ruttan that "If the research effort required to maintain productivity is a positive function of the productivity level, it is apparent that maintenance research will rise as a share of the research budget."

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Appendix A. Maintenance Research Questionnaire

VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

Department of Agricultural Economics
Blacksburg, Virginia 24061

June 4, 1987

Dear

We are in the process of conducting a study of the importance of maintenance research to U.S. agriculture. Because the effects of any particular research result can "depreciate" or deteriorate over time, the absence of ongoing research may lead to declines in agricultural productivity. **Maintenance research is defined as the research needed to prevent crop and livestock productivity from declining.** Maintenance research has also been referred to as "protective" research, "productivity sustaining" research, and "defense-of-gains" research.

The following are examples of research depreciation leading to maintenance research:

- Race 15 b of wheat rust in the United States reduced wheat production in 1953-54 and was followed by research to develop new resistant varieties.
- A new strain of southern corn leaf blight provided an average 15% drop in U.S. maize yields in 1970. This spurred research which resulted in new hybrids based on other parents.
- In S. E. Asia, new hopper populations against rice variety IR36 appeared in 1982. Researchers at the International Rice Research Institute were prepared for changes in the hopper populations; IR56 was multiplied to replace IR36, and IR60 was released in 1983 to ensure that there will not be further declines in rice production.
- Researchers often seek antibiotics to combat diseases in livestock caused by pathogenic bacteria, and other factors. However, over time, these diseases may begin to resist the antibiotics and start to attack the animals. As a result, livestock productivity begins to decline, making it necessary to conduct additional research to maintain or sustain productivity levels.

While it is frequently recognized that research increases agricultural productivity, these four examples illustrate that **a portion of the benefits of research stems from the maintaining of past productivity gains.** Unless we measure that maintenance effort we may undervalue agricultural research.

Not all maintenance research relates to insects or diseases as the above examples might suggest. We would greatly appreciate your assistance in filling out the attached questionnaire to help us assess the importance of maintenance research in your field. If you have any questions or comments concerning this survey, please do not hesitate to call us at
Thank you for your cooperation.

Maintenance Research Questionnaire

1. Are you conducting research related to a particular commodity? Yes ____ No ____

If yes, which commodity or commodities, and indicate the percentage of your research devoted to each commodity?

____

____

2. What is the major objective(s) of your research?

____

____

3. Have you observed an example(s) of research depreciation related to research in your field? Yes ____ No ____

If yes, please describe briefly (If no, please go to question 5):

____

____

____

4. If the answer to (3) is yes, was maintenance research undertaken to replace the depreciated research? Yes ____ No ____

If yes, please describe briefly:

____

____

____

____

5. What is the approximate annual budget of your research program, not including your salary? ________

6. What percentage of your research effort is devoted to **maintenance** research? ________

7. If you listed more than one commodity in question 1, does the percentage of your research devoted to maintenance research vary by commodity? Yes ____ No ____

If yes, please list this percentage by commodity?____________________

____

Please provide any additional comments on the reverse side of this sheet.

Appendix B. Data Used in the Profit Function Model

The abbreviated variable names are defined as follows:

EXT82	Extension Expenditures for 1982
EDUC82	Education Expenditures for 1982
PMILK81	Price of milk in 1981
PMILK82	Price of milk in 1982
HOG81	Quantity of hogs in 1981
VHOG81	Value of hogs in 1981
MILK81	Quantity of Milk in 1981
SUN81	Quantity of sunflower in 1981
EGG81	Quantity of eggs in 1981
TURK81	Quantity of turkey in 1981
BRO81	Quantity of of broilers in 1981
CHICK81	Quantity of chickens in 1981
SHEEP81	Quantity of sheep in 1981
VSHEEP81	Value of sheep in 1981

CAT81	Quantity of cattle in 1981
VCAT81	Value of cattle in 1981
HAY81	Quantity of hay in 1981
PEACH81	Quantity of peaches in 1981
VEG81	Quantity of vegetables in 1981
VVEG81	Value of vegetables in 1981
PEA81	Quantity of peanuts in 1981
SOY81	Quantity of soybeans in 1981
APP81	Quantity of apples in 1981
GRAPE81	Quantity of of grapes in 1981
SORG81	Quantity of sorghum in 1981
COT81	Quantity of cotton in 1981
SUG81	Quantity of sugarbeets in 1981
CANE81	Quantity of sugarcane in 1981
TOB81	Quantity of tobacco in 1981
WHE81	Quantity of wheat in 1981

RICE81	Quantity of rice in 1981
CORN81	Quantity of corn in 1981
OAT81	Quantity of oats in 1981
BAR81	Quantity of barley in 1981
DIESEL82	Quantity of diesel fuel in 1982
PLPG82	Quantity of Propane gas in 1982
GASO821	Quantity of gasoline in 1981
OIL82	Quantity of oil in 1982
MILK82	Quantity of milk in 1982
VMILK82	Value of milk in 1982
SHEEP82	Quantity of sheep in 1982
VSHEEP82	Value of sheep in 1982
COW82	Quantity of of cattle in 1982
HOG82	Quantity of hogs in 1982
EWE82	Quantity of ewes in 1982
FEED82	Quantity of feed in 1982

BEET82	Quantity of sugarbeets in 1982
PCANE82	Quantity of sugarcane in 1982
VEG82	Quantity of vegetables in 1982
VVEG82	Value of vegetables in 1982
RES79	Research expenditures in 1979
RES80	Research expenditures in 1980
RES81	Research expenditures in 1981
RES82	Research expenditures in 1982
RAIN82	Deviations from normal rainfall in 1982
W4	Land quality index constructed by Peterson
SOY82	Quantity of soybean in 1982
COT82	Quantity of cattle in 1982
TOB82	Quantity of tobacco in 1982
PEA82	Quantity of peanuts in 1982
HAY82	Quantity of of hay in 1982
POT82	Quantity of potatoes in 1982

SUG82	Quantity of sorghum in 1982
CANE82	Quantity of sugarcane in 1982
RICE82	Quantity of rice in 1982
SUN82	Quantity of sunflower in 1982
PEACH82	Quantity of peaches in 1982
GRAPES82	Quantity of grapes in 1982
APP82	Quantity of apples in 1982
CHICK82	Quantity of chickens in 1982
VCHICK82	Value of chickens in 1982
BRO82	Quantity of broilers in 1982
PBRO82	Price of broilers in 1982
TURK82	Quantity of turkeys in 1982
PTURK82	Price of turkey in 1982
EGG82	Quantity of eggs in 1982
PEGG82	Price of eggs in 1982
FARM82	Number of farms in 1982

VLAND82	Value of land in 1982
LAND82	Acres of agricultural land in 1982
PAS82	Land under pasture in 1982
IRR82	Irrigated land in 1982
PA82	Acres set-aside in 1982
FERT82	Quantity of fertilizer used in 1982
LAB82	Quantity of own labor in 1982
CONL82	Quantity of contract labor in 1982
CUST82	Quantity of custom labor in 1982
PRICE82	Price of rice in 1982
PSUN82	Price of sunflower in 1982
PSOY82	Price of soybeans in 1982
PRICE81	Price of rice in 1981
PSUN81	Price of sunflower in 1981
PSOY81	Price of soybeans in 1981
PAP82	price of apples in 1982

PGRA82	Price of grapes in 1982
QOR81	Quantity of oranges in 1981
QGF81	Quantity of grapefruit in 1981
POR81	Price of oranges in 1981
PGF81	Price of grapefruit in 1981
QOR77	Quantity of oranges in 1977
QOR78	Quantity of oranges in 1978
POR77	Price of oranges in 1977
POR78	Price of oranges in 1978
QGF77	Quantity of grapefruit In 1977
QGF78	Quantity of grapefruit in 1978
PGF77	Price of grapefruit in 1977
PGF78	Price of grapefruit in 1978
PHAY78	Price of hay in 1978
HFLABOR	Quantity of own labor in 1978
CLABOR	Quantity of custom labor in 1978

TURK	Quantity of turkey in 1978
PTURK	Price of turkey in 1978
PEACH	Quantity of peaches in 1978
GRAPE	Quantity of grapes in 1981
WAGE	Wage rate in 1978
QFERT	Quantity of fertilizer used in 1978
FEED	Quantity of feed used in 1978
VFEED	Value of feed used in 1978
POTATO	Quantity of potatoes in 1978
BEETS	Quantity of sugarbeets in 1978
SUGAR	Quantity of sugarcane in 1978
QRICE	Quantity of rice in 1978
QSUN	Quantity of sunflower in 1978
EDUC	Education expenditures in 1978
EXT	Extension expenditures in 1978
PCORN	Price of corn in 1978

PSORGH	Price of sorghum in 1978
PWHE	Price of wheat in 1978
POAT	Price of oats in 1978
PBARLEY	Price of barley in 1978
PRICE	Price of rice in 1978
PSUN	Price of sunflower in 1981
PSOY	Price of soybeans in 1978
CHICK	Quantity of chickens in 1978
VCHICK	Value of chickens in 1978
BROIL	Quantity of broilers in 1978
PBROIL	Price of broilers in 1978
PAPPLE	Price of apples in 1978
PGRAPES	Price of grapes in 1978
PPEACH	Price of peaches in 1978
PBEET	Price of sugarbeets in 1978
PSUGAR	Price of sugarcane in 1978

VEG1	Quantity of vegetables in 1978
VVEG1	Value of vegetables in 1978
MILK	Quantity of milk in 1978
VMILK	Value of milk in 1978
CATTLE	Quantity of cattle in 1978
VCATTLE	Value of cattle in 1978
HOGS	Quantity of hogs in 1978
VHOGS	Value of hogs in 1978
SHEEP	Quantity of sheep in 1978
VSHEEP	Value of sheep in 1978
EGGS	Quantity of eggs in 1978
PEGGS	Price of eggs in 1978
PPOT77	Price of potatoes in 1978
PCOT78	Price of cotton in 1978
PTOB78	Price of tobacco in 1978
PPEA78	Price of peanuts in 1978

PPOT78	Price of potatoes in 1978
PCORN77	Price of corn in 1977
PSOR77	Price of sorghum in 1977
PWHE77	Price of wheat in 1977
POAT77	Price of oats in 1977
PBAR77	Price of barley in 1977
PRIC77	Price of rice in 1977
PSUN77	Price of sunflowerin 1977
PSOY77	Price of soybeans in 1977
PTUR77	Price of turkey in 1977
PEGG77	Price of eggs in 1977
PBRO77	Price of broilers in 1977
PAP77	Price of apples in 1977
PGR77	Price of grapes in 1977
PPCH77	Price of peaches in 1977
PSU77	Price of sugarbeets in 1977

PCAN77	Price of sugarcane in 1977
PCHI77	Price of chicken in 1978
PCOT77	Price of cotton in 1978
PTOB77	Price of tobacco in 1977
PPEA77	Price of peanuts in 1977
CAT77	Quantity of cattle in 1977
VCAT77	Value of cattle in 1977
HOG77	Quantity of hogs in 1977
VHOG77	Value of hogs in 1977
SHE77	Quantity of sheep in 1977
VSHE77	Value of sheep in 1977
MILK77	Quantity of milk in 1977
VMILK77	Value of milk in 1977
VEG77	Quantity of vegetables in 1977
VVEG77	Value of vegetables in 1977
PGAS	Price of gasoline in 1977

PDIESEL	Price of diesel fuel in 1977
PMOTOR	Price of motor oil in 1977
PFUEL	Price of liquid fuel in 1977
PPLPG	Price of LP gas in 1978
CHI77	Quantity of chicken in 1977
BRO77	Quantity of broilers in 1977
EGG77	Quantity of eggs in 1977
TURK77	Quantity of turkeys in 1977
RAIN	Deviation from normal rainfall
COWS	Quantity of cattle in 1977
SOWS	Value of hogs in 1977
EWES	Quantity of ewes in 1977
PHAY	Price of hay in 1977
GAS	Quantity of gasoline in 1977
DIESEL	Quantity of diesel fuel in 1977
LPG	Quantity of Lp gas in 1977

FUEL	Quantity of liquid fuel in 1977
MOTOR	Price of motor oil in 1977
FARMS	Number of farms in 1978
VLAND	Value of land in 1978
ILAND	Acres of irrigated land in 1978
CORN	Quantity of corn in 1978
SORGH	Quantity of sorghun in 1978
WHEAT	Quantity of wheat in 1978
OATS	Quantity of oats in 1978
BARLEY	Quantity of barley in 1978
SOYBEA	Quantity of soybean in 1978
COTTON	Quantity of cotton in 1978
TOBACC	Quantity of tobacco in 1978
PEANUT	Quantity of peanuts in 1978
HAYCROP	Quantity of hay in 1978
APHA	Quantity of apples in 1978

RSH67	Research expenditures in 1967
RSH68	Research expenditures in 1968
RSH69	Research expenditures in 1969
RSH70	Research expenditures in 1970
RSH71	Research expenditures in 1971
RSH72	Research expenditures in 1972
RSH73	Research expenditures in 1973
RSH74	Research expenditures in 1974
RSH75	Research expenditures in 1975
RSH76	Research expenditures in 1976
RSH77	Research expenditures in 1977
RSH78	Research expenditures in 1978

	EXT82	EDUC82
ALABAMA	19428018	6316
ARIZONA	5637536	6563
ARKANSAS	15342799	6133
CALIFORNIA	39368790	7352
COLORADO	11931343	7420
CONNECTICUT	3728487	7957
DELAWARE	2145892	6396
FLORIDA	23250820	6699
GEORGIA	29223431	6260
IDAHO	5730897	7451
ILLINOIS	22432639	6941
INDIANA	18575795	7151
IOWA	19872596	7074
KANSAS	19862273	7244
KENTUCKY	20074554	5946
LOUISIANA	19269287	6200
MAINE	4034388	7528
MARYLAND	10583022	6797
MASSACHUSETTS	6709475	7810
MICHIGAN	23469097	6942
MINNESOTA	19523012	6470
MISSISSIPPI	19458840	6759
MISSOURI	21312624	6759
MONTANA	5438601	7202
NEBRASKA	13587622	6979
NEVADA	2872293	7719
NEW-HAMPSHIRE	2820096	7769
NEW-JERSEY	9213260	7503
NEW-MEXICO	5750238	6550
NEW-YORK	29786580	7261
NORTH-CAROLINA	32094523	5825
NORTH-DAKOTA	7304941	6531
OHIO	21637670	7113
OKLAHOMA	15713889	6924
OREGON	10871198	7560
PENNSYLVANIA	16855252	6860
RHODE-ISLAND	1626732	8180
SOUTH-CAROLINA	16766095	6145
SOUTH-DAKOTA	6206656	7990
TENNESSEE	19018566	5926
TEXAS	42109484	6645
UTAH	5476136	7712
VERMONT	3237024	7084
VIRGINIA	26161276	5875
WASHINGTON	13293037	7645
WEST-VIRGINIA	7555575	6262
WISCONSIN	23562660	6558
WYOMING	3554251	7606

	PMILK81	PMILK82	HOG81	VHOG81	MILK81
ALABAMA	14.70	14.60	279801	126602	582
ARIZONA	14.10	13.90	59222	27425	1133
ARKANSAS	14.50	14.40	209960	93200	793
CALIFORNIA	13.43	13.21	61076	29192	14244
COLORADO	14.90	14.80	111035	49007	928
CONNECTICUT	14.50	14.40	4800	2064	620
DELAWARE	14.30	13.90	14115	6432	124
FLORIDA	16.80	16.40	120425	52554	2082
GEORGIA	14.70	14.40	578204	248546	1396
IDAHO	12.80	12.70	504196	20984	2160
ILLINOIS	13.80	13.50	2564976	1126252	2604
INDIANA	13.80	13.60	1543975	673739	2282
IOWA	13.30	13.20	5667090	2456043	4298
KANSAS	14.00	14.00	722452	307484	1397
KENTUCKY	13.60	13.50	354528	162951	2281
LOUISIANA	14.90	14.70	39627	16528	993
MAINE	14.80	14.70	6722	2891	699
MARYLAND	14.30	14.00	90071	41450	1556
MASSACHUSETTS	14.60	14.50	13267	5705	578
MICHIGAN	13.80	13.60	288235	125441	5103
MINNESOTA	13.08	12.98	1694340	743865	10061
MISSISSIPPI	14.40	14.20	105801	47047	845
MISSOURI	13.40	13.30	1380913	607242	2877
MONTANA	13.40	13.20	82089	33974	331
NEBRASKA	13.40	13.30	1398110	606899	1400
NEVADA	13.40	13.30	3979	1303	222
NEW-HAMPSHIRE	14.50	14.50	3526	1516	344
NEW-JERSEY	14.10	13.90	12784	4820	494
NEW-MEXICO	15.30	15.30	19828	8468	670
NEW-YORK	13.80	13.70	44232	19506	11093
NORTH-CAROLINA	15.00	14.70	782723	344568	1654
NORTH-DAKOTA	12.60	12.50	90210	37679	963
OHIO	13.80	13.70	668813	295792	4385
OKLAHOMA	14.40	14.40	111134	47579	1150
OREGON	13.90	13.80	39261	17342	1220
PENNSYLVANIA	14.20	14.00	259194	121342	8965
RHODE-ISLAND	14.50	14.50	1930	830	46
SOUTH-CAROLINA	15.60	15.30	188045	77663	552
SOUTH-DAKOTA	12.90	13.00	631140	277737	1757
TENNESSEE	13.90	13.60	354592	158058	2296
TEXAS	14.80	14.60	264693	110418	3665
UTAH	13.10	12.90	15718	6364	1110
VERMONT	14.30	14.10	7096	3052	2301
VIRGINIA	14.10	13.90	232918	103328	2009
WASHINGTON	13.50	13.30	26446	12087	3017
WEST-VIRGINIA	13.80	13.60	28781	12808	350
WISCONSIN	13.38	13.22	568668	252670	22705
WYOMING	13.30	13.10	11247	4830	136

	SUN81	EGG81	TURK81	BRO81	CHICK81
ALABAMA	0	3095	0	1973294	69982
ARIZONA	0	98	0	0	836
ARKANSAS	0	3996	274274	2497907	122680
CALIFORNIA	0	8400	444067	746360	80025
COLORADO	0	552	111370	0	7934
CONNECTICUT	0	990	596	0	13040
DELAWARE	0	175	3809	763182	4963
FLORIDA	0	2802	0	369400	40741
GEORGIA	0	5578	65343	2397279	105882
IDAHO	0	228	0	0	2397
ILLINOIS	0	1262	8466	0	14772
INDIANA	0	4093	119659	125861	56113
IOWA	0	1920	158816	13950	26615
KANSAS	0	416	4420	0	9196
KENTUCKY	0	509	0	11004	6833
LOUISIANA	0	510	0	406949	12129
MAINE	0	1607	0	125861	34534
MARYLAND	0	547	1734	1089246	11183
MASSACHUSETTS	0	321	3045	0	8266
MICHIGAN	0	1541	40300	4520	22787
MINNESOTA	823550	2355	424050	96750	29147
MISSISSIPPI	0	1717	0	1131460	40210
MISSOURI	0	1431	226800	104400	35307
MONTANA	0	174	0	0	3362
NEBRASKA	0	802	13532	6636	7307
NEVADA	0	2	0	0	32
NEW-HAMPSHIRE	0	157	560	0	4458
NEW-JERSEY	0	291	1442	0	3885
NEW-MEXICO	0	347	0	0	5355
NEW-YORK	0	1858	5869	2430	31700
NORTH-CAROLINA	0	3078	469000	1734956	88045
NORTH-DAKOTA	3158160	80	19635	0	5274
OHIO	0	2431	54750	51200	40710
OKLAHOMA	0	839	30495	193291	10027
OREGON	0	665	24235	79200	7083
PENNSYLVANIA	0	4268	107920	460232	93442
RHODE-ISLAND	0	88	0	0	1174
SOUTH-CAROLINA	0	1613	69262	165760	22871
SOUTH-DAKOTA	472600	461	37350	0	4590
TENNESSEE	0	922	0	232276	11994
TEXAS	33100	3224	148190	926800	41020
UTAH	0	459	65273	0	3916
VERMONT	0	81	0	0	1418
VIRGINIA	0	947	175263	562124	19458
WASHINGTON	0	1332	0	94080	19663
WEST-VIRGINIA	0	155	34384	87465	3975
WISCONSIN	0	951	116553	49800	16598
WYOMING	0	8	0	0	126

	SHEEP81	VSHEEP81	CAT81	VCAT81
ALABAMA	0	0	653260	322915
ARIZONA	20550	8865	554435	343115
ARKANSAS	0	0	624120	317971
CALIFORNIA	64675	32947	1748325	1013083
COLORADO	52506	27102	1464360	917598
CONNECTICUT	327	248	27005	13671
DELAWARE	0	0	6785	3769
FLORIDA	0	0	567810	315152
GEORGIA	0	0	516430	248792
IDAHO	47185	22250	764650	440837
ILLINOIS	14490	5948	912980	533731
INDIANA	8840	3537	567945	320018
IOWA	27888	12873	2871150	1668126
KANSAS	12486	6670	2753420	1622505
KENTUCKY	1938	940	817410	427717
LOUISIANA	436	176	323980	166850
MAINE	820	563	31780	16078
MARYLAND	1244	537	106000	60126
MASSACHUSETTS	423	341	24040	12101
MICHIGAN	8140	3693	425410	213308
MINNESOTA	24358	10801	1486740	762374
MISSISSIPPI	0	0	495720	247510
MISSOURI	8994	4147	1715505	1013550
MONTANA	36494	13365	1096755	590731
NEBRASKA	14396	6684	2891770	1803725
NEVADA	9395	4688	198935	106209
NEW-HAMPSHIRE	457	333	17390	8500
NEW-JERSEY	471	198	28460	15616
NEW-MEXICO	23519	10888	501770	265611
NEW-YORK	4268	1908	410540	195115
NORTH-CAROLINA	365	159	285705	135307
NORTH-DAKOTA	16522	6755	806420	455898
OHIO	19514	9521	600650	314613
OKLAHOMA	6311	3093	2167990	1252432
OREGON	33424	14784	577395	307430
PENNSYLVANIA	6554	3669	573105	310418
RHODE-ISLAND	0	0	1875	947
SOUTH-CAROLINA	0	0	178685	88693
SOUTH-DAKOTA	69587	33668	1782090	1064121
TENNESSEE	513	301	623845	295707
TEXAS	106650	51898	5374950	3354132
UTAH	38961	17957	318340	173149
VERMONT	725	405	64700	34689
VIRGINIA	12191	5904	499470	257163
WASHINGTON	6250	2716	515730	322978
WEST-VIRGINIA	7252	3405	135580	71144
WISCONSIN	9605	4689	1136825	689435
WYOMING	52554	19263	545210	324321

	HAY81	PEACH81
ALABAMA	1152	22
ARIZONA	1216	0
ARKANSAS	1696	37
CALIFORNIA	7851	434
COLORADO	3105	20
CONNECTICUT	175	.3
DELAWARE	45	1.6
FLORIDA	552	0
GEORGIA	1021	140
IDAHO	4453	12
ILLINOIS	3501	22
INDIANA	2210	7
IOWA	8224	0
KANSAS	6070	6.5
KENTUCKY	3319	16
LOUISIANA	805	6
MAINE	414	0
MARYLAND	508	17
MASSACHUSETTS	272	.2
MICHIGAN	4094	35
MINNESOTA	8206	0
MISSISSIPPI	1249	3
MISSOURI	6584	15
MONTANA	4964	0
NEBRASKA	7010	0
NEVADA	1081	0
NEW-HAMPSHIRE	196	0
NEW-JERSEY	283	90
NEW-MEXICO	1350	0
NEW-YORK	5273	9
NORTH-CAROLINA	636	40
NORTH-DAKOTA	4315	0
OHIO	3599	2
OKLAHOMA	3511	13
OREGON	2886	13
PENNSYLVANIA	4535	65
RHODE-ISLAND	22	0
SOUTH-CAROLINA	414	430
SOUTH-DAKOTA	5628	0
TENNESSEE	2078	10
TEXAS	6959	34
UTAH	2204	12
VERMONT	959	0
VIRGINIA	1640	30
WASHINGTON	2559	20
WEST-VIRGINIA	817	18
WISCONSIN	10725	0
WYOMING	2154	0

	VEG81	VVEG81
ALABAMA	36470	13657
ARIZONA	515700	134235
ARKANSAS	24630	7971
CALIFORNIA	9936390	1585125
COLORADO	252410	57798
CONNECTICUT	11100	2708
DELAWARE	34390	5167
FLORIDA	1152000	395158
GEORGIA	10080	3527
IDAHO	296900	47746
ILLINOIS	302620	33017
INDIANA	102280	11595
IOWA	27260	1481
KANSAS	0	0
KENTUCKY	0	0
LOUISIANA	2050	1054
MAINE	13050	2179
MARYLAND	114220	14830
MASSACHUSETTS	45550	12028
MICHIGAN	488710	92235
MINNESOTA	707270	59888
MISSISSIPPI	0	0
MISSOURI	3200	512
MONTANA	0	0
NEBRASKA	0	0
NEVADA	0	0
NEW-HAMPSHIRE	0	0
NEW-JERSEY	245630	53163
NEW-MEXICO	101430	28009
NEW-YORK	628980	144517
NORTH-CAROLINA	42200	9910
NORTH-DAKOTA	0	0
OHIO	349710	46228
OKLAHOMA	6080	973
OREGON	812340	127601
PENNSYLVANIA	180250	29486
RHODE-ISLAND	0	0
SOUTH-CAROLINA	77200	20773
SOUTH-DAKOTA	0	0
TENNESSEE	45100	16198
TEXAS	483500	181963
UTAH	59050	11236
VERMONT	0	0
VIRGINIA	60160	18364
WASHINGTON	625990	77868
WEST-VIRGINIA	480	37
WISCONSIN	1061040	107767
WYOMING	0	0

	POT1	POT2	POT3	POT4
ALABAMA	0	720	1365	0
ARIZONA	0	1456	0	0
ARKANSAS	0	0	0	0
CALIFORNIA	896	10296	2960	6919
COLORADO	0	0	1904	11600
CONNECTICUT	0	0	0	486
DELAWARE	0	0	1248	0
FLORIDA	1302	5263	0	0
GEORGIA	0	0	0	0
IDAHO	0	0	0	84480
ILLINOIS	0	0	525	0
INDIANA	0	0	272	615
IOWA	0	0	270	0
KANSAS	0	0	0	0
KENTUCKY	0	0	0	0
LOUISIANA	0	128	0	0
MAINE	0	0	0	26520
MARYLAND	0	0	312	0
MASSACHUSETTS	0	0	0	743
MICHIGAN	0	0	1960	8575
MINNESOTA	0	0	1647	13300
MISSISSIPPI	0	0	0	0
MISSOURI	0	0	0	0
MONTANA	0	0	0	1739
NEBRASKA	0	0	220	2252
NEVADA	0	0	0	3480
NEW-HAMPSHIRE	0	0	0	0
NEW-JERSEY	0	0	2066	0
NEW-MEXICO	0	0	945	0
NEW-YORK	0	0	0	12240
NORTH-CAROLINA	0	2100	480	0
NORTH-DAKOTA	0	0	0	20125
OHIO	0	0	228	1890
OKLAHOMA	0	0	0	0
OREGON	0	0	0	21710
PENNSYLVANIA	0	0	0	5250
RHODE-ISLAND	0	0	0	832
SOUTH-CAROLINA	0	0	0	0
SOUTH-DAKOTA	0	0	0	702
TENNESSEE	0	0	279	0
TEXAS	0	840	1541	0
UTAH	0	0	0	1342
VERMONT	0	0	0	110
VIRGINIA	0	0	2320	0
WASHINGTON	0	0	0	52920
WEST-VIRGINIA	0	0	0	0
WISCONSIN	0	0	0	18190
WYOMING	0	0	0	1060

	PEA81	SOY81	APP81	GRAPE81
ALABAMA	602730	46460	0	0
ARIZONA	0	0	0	12400
ARKANSAS	0	99000	23	6000
CALIFORNIA	0	0	626	3993000
COLORADO	0	0	75	0
CONNECTICUT	0	0	38	0
DELAWARE	0	6885	13.1	0
FLORIDA	178200	9840	0	0
GEORGIA	1655450	41800	45	2800
IDAHO	0	0	135	0
ILLINOIS	0	347700	103	0
INDIANA	0	151800	68	0
IOWA	0	322000	11	0
KANSAS	0	45300	14	0
KENTUCKY	0	47850	21	0
LOUISIANA	0	63630	0	0
MAINE	0	0	80	0
MARYLAND	0	10473	70	0
MASSACHUSETTS	0	0	83	0
MICHIGAN	0	31200	660	53000
MINNESOTA	0	139200	22	0
MISSISSIPPI	12730	77700	0	0
MISSOURI	0	150000	62	2200
MONTANA	0	0	0	0
NEBRASKA	0	78660	0	0
NEVADA	0	0	0	0
NEW-HAMPSHIRE	0	0	45	0
NEW-JERSEY	0	4872	95	0
NEW-MEXICO	24900	0	17	0
NEW-YORK	0	0	800	150000
NORTH-CAROLINA	555560	46250	375	5100
NORTH-DAKOTA	0	6860	0	0
OHIO	0	98325	100	10300
OKLAHOMA	189280	6480	0	0
OREGON	0	0	155	0
PENNSYLVANIA	0	4030	400	61000
RHODE-ISLAND	0	0	4.5	0
SOUTH-CAROLINA	39000	31000	36	2800
SOUTH-DAKOTA	0	22330	0	0
TENNESSEE	0	58750	11	0
TEXAS	393250	10560	0	0
UTAH	0	0	54	0
VERMONT	0	0	28	0
VIRGINIA	330750	17780	465	0
WASHINGTON	0	0	2760	159000
WEST-VIRGINIA	0	0	200	0
WISCONSIN	0	12375	59	0
WYOMING	0	0	0	0

	SORG81	COT81	SUG81	CANE81	TOB81
ALABAMA	2146	422	0	0	0
ARIZONA	2028	1556	300	0	0
ARKANSAS	16986	604	0	0	0
CALIFORNIA	6808	3535	7254	0	0
COLORADO	12045	0	1733	0	0
CONNECTICUT	0	0	0	0	5645
DELAWARE	0	0	0	0	0
FLORIDA	0	21.3	0	10019	22848
GEORGIA	4455	159	0	0	121000
IDAHO	0	0	3754	0	0
ILLINOIS	7560	0	0	0	0
INDIANA	720	0	0	0	18800
IOWA	1600	0	0	0	0
KANSAS	238520	0	284	0	0
KENTUCKY	2250	0	0	0	509576
LOUISIANA	2880	742	0	7134	45
MAINE	0	0	0	0	0
MARYLAND	0	0	0	0	33000
MASSACHUSETTS	0	0	0	0	1970
MICHIGAN	0	0	2030	0	0
MINNESOTA	0	0	4403	0	0
MISSISSIPPI	3872	1565	0	0	0
MISSOURI	69420	168	0	0	6076
MONTANA	0	0	926	0	0
NEBRASKA	164800	0	1889	0	0
NEVADA	0	1.5	0	0	0
NEW-HAMPSHIRE	0	0	0	0	0
NEW-JERSEY	0	0	0	0	0
NEW-MEXICO	12240	133	43	0	0
NEW-YORK	0	0	0	0	0
NORTH-CAROLINA	4080	95	0	0	795887
NORTH-DAKOTA	0	0	2695	0	0
OHIO	0	0	274	0	22854
OKLAHOMA	24675	440	0	0	0
OREGON	0	0	300	0	0
PENNSYLVANIA	0	0	0	0	27265
RHODE-ISLAND	0	0	0	0	0
SOUTH-CAROLINA	576	164	0	0	149580
SOUTH-DAKOTA	19565	0	0	0	0
TENNESSEE	4650	315	0	0	161463
TEXAS	273420	5645	575	1174	0
UTAH	0	0	0	0	0
VERMONT	0	0	0	0	0
VIRGINIA	539	.3	0	0	158797
WASHINGTON	0	0	0	0	0
WEST-VIRGINIA	0	0	0	0	2430
WISCONSIN	0	0	0	0	26353
WYOMING	0	0	1078	0	0

	WHE81	RICE81	CORN81	OAT81	BAR81
ALABAMA	24860	0	29150	2360	0
ARIZONA	21844	0	3900	0	3312
ARKANSAS	67650	69610	3185	2100	0
CALIFORNIA	105545	40924	35750	3900	40320
COLORADO	87877	0	103950	1300	16740
CONNECTICUT	0	0	0	0	0
DELAWARE	1920	0	15385	0	1716
FLORIDA	0	0	18639	0	0
GEORGIA	46010	0	69000	4500	0
IDAHO	89780	0	7475	2990	63720
ILLINOIS	97500	0	1426320	13530	0
INDIANA	59800	0	648000	5525	0
IOWA	4875	0	1731250	59520	0
KANSAS	302500	0	148050	9000	1664
KENTUCKY	28560	0	146020	288	2016
LOUISIANA	11550	27078	2475	0	0
MAINE	0	0	0	3150	0
MARYLAND	5617	0	69360	1100	5040
MASSACHUSETTS	0	0	0	0	0
MICHIGAN	41500	0	268800	21080	1404
MINNESOTA	140025	0	744700	90090	57680
MISSISSIPPI	24000	14792	6440	0	0
MISSOURI	115500	3099	207580	4680	0
MONTANA	172830	0	850	4840	56760
NEBRASKA	104400	0	791200	15800	858
NEVADA	1850	0	0	0	1650
NEW-HAMPSHIRE	0	0	0	0	0
NEW-JERSEY	2352	0	12870	385	976
NEW-MEXICO	11000	0	8320	0	1876
NEW-YORK	7040	0	77190	17920	0
NORTH-CAROLINA	21450	0	140910	4648	4125
NORTH-DAKOTA	328260	0	41553	44160	100800
OHIO	70400	0	360000	17010	0
OKLAHOMA	172800	0	4500	3780	837
OREGON	74330	0	2970	4550	12300
PENNSYLVANIA	8640	0	134400	20010	4104
RHODE-ISLAND	0	0	0	0	0
SOUTH-CAROLINA	14350	0	33060	2208	1161
SOUTH-DAKOTA	88970	0	180600	70520	20060
TENNESSEE	37400	0	53760	816	0
TEXAS	183400	27239	127530	18860	2100
UTAH	9340	0	1650	896	11088
VERMONT	0	0	0	0	0
VIRGINIA	17160	0	56250	940	5917
WASHINGTON	168350	0	14820	1600	44080
WEST-VIRGINIA	324	0	7728	572	330
WISCONSIN	5518	0	378000	52606	1900
WYOMING	8280	0	5060	2295	8978

	DIESEL82	PLPG82	GASO82	OIL82
AL	1.13	.683	1.23	5.09
AZ	1.11	.903	1.20	5.04
AR	1.06	.751	1.20	4.25
CA	1.11	.873	1.22	5.08
CO	1.08	.663	1.20	4.16
CT	1.21	1.020	1.26	5.85
DE	1.10	.818	1.19	4.66
FL	1.15	.925	1.14	5.63
GA	1.10	.737	1.20	5.38
ID	1.11	.776	1.25	4.11
IL	1.18	.651	1.27	4.90
IN	1.15	.721	1.24	4.20
IA	1.10	.628	1.27	4.94
KS	1.10	.603	1.20	4.19
KY	1.09	.768	1.22	4.21
LA	1.06	.820	1.19	4.69
ME	1.21	1.023	1.26	5.85
MD	1.21	.818	1.19	4.66
MA	1.21	1.023	1.26	5.85
MI	1.16	.723	1.23	3.75
MN	1.13	.713	1.28	3.70
MS	1.23	.773	1.28	5.40
MO	1.11	.680	1.18	4.19
MT	1.13	.670	1.24	4.43
NE	1.09	.546	1.26	3.98
NV	1.16	.882	1.26	4.13
NH	1.21	1.023	1.26	5.85
NJ	1.15	.916	1.18	5.20
NM	1.11	.710	1.23	4.38
NY	1.24	1.010	1.25	5.38
NC	1.19	.755	1.21	4.71
ND	1.14	.643	1.24	3.88
OH	1.15	.749	1.25	4.58
OK	1.13	.676	1.18	4.49
OR	1.08	.806	1.20	4.53
PA	1.17	.873	1.23	4.09
RI	1.21	1.023	1.26	5.85
SC	1.17	.844	1.24	4.81
SD	1.15	.640	1.27	4.11
TN	1.09	.829	1.19	4.90
TX	1.09	.695	1.18	5.30
UT	1.10	.804	1.23	4.29
VT	1.21	1.023	1.26	5.85
VA	1.18	.795	1.22	4.69
WA	1.12	.960	1.27	5.09
WV	1.36	.932	1.23	5.45
WI	1.13	.749	1.26	4.06
WY	1.11	.734	1.22	4.53

	MILK82	VMILK82	SHEEP82	VSHEEP82
AL	580	84680	0	0
AZ	1202	168710	17170	7394
AR	828	118224	0	0
CA	14528	1948316	79391	41095
CO	972	147355	59594	30439
CT	644	94135	314	188
DE	137	18765	0	0
FL	2109	345876	0	0
GA	1412	203328	0	0
ID	2253	289285	45962	22067
IL	2657	358695	14020	5789
IN	2334	317424	7575	2916
IA	4301	567732	29786	13236
KS	1356	190382	10650	5773
KY	2364	319140	1878	891
LA	975	142464	383	158
ME	727	108115	882	506
MD	1581	221340	1101	523
MA	602	89369	377	242
MI	5253	715984	6335	2927
MN	10341	1342262	23693	10742
MS	900	128880	0	0
MO	2905	386365	7878	3390
MT	341	45353	43589	16788
NE	1340	180880	13190	6121
NV	225	29925	8925	3615
NH	365	53434	449	286
NJ	492	69667	582	214
NM	812	126422	21287	9179
NY	11097	1533827	3384	1436
NC	1686	247842	360	151
ND	1020	125625	14871	5629
OH	45550	625170	16088	8120
OK	1165	169974	5879	2811
OR	1301	184222	27459	13282
PA	9264	1319194	5587	2877
RI	46	6891	0	0
SC	567	89062	0	0
SD	1762	229589	57983	27819
TN	2326	316801	482	216
TX	3780	555698	124060	53008
UT	1162	151757	34921	16172
VT	2385	333373	714	402
VA	2059	286201	11895	5482
WA	3222	440125	5519	2296
WV	349	48302	7215	3215
WI	23230	3071006	7601	3761
WY	137	17947	55061	20038

	COWS82	HOGS82	EWE82	FEED82
AL	841187	62758	1616	2438580
AZ	320077	19601	65108	387186
AR	904394	55876	6729	3235219
CA	1887466	26413	645449	6192578
CO	917749	41821	385523	684234
CT	58242	1207	3993	402011
DE	15085	8689	358	799697
FL	1279760	28308	3867	1681414
GA	817686	156059	3633	3601641
ID	785922	9555	273272	483907
IL	827253	762404	98939	1059111
IN	564648	517108	65244	1798073
IA	1874350	1699133	296878	2634638
KS	1645576	207873	150502	1160177
KY	1234611	116964	20385	511628
LA	575661	7118	6228	753475
ME	70415	1796	11709	543785
MD	179450	26585	11937	1439619
MA	57347	4608	6126	214165
MI	537477	154268	68288	860366
MN	1306444	558387	180996	2446580
MS	806155	27055	2876	1525236
MO	2199424	455778	89914	1936473
MT	1535143	22768	376119	183461
NE	2134412	469207	123262	1216014
NV	292149	1973	66827	68737
NH	34832	1117	5507	115834
NJ	49757	4190	7009	123627
NM	599976	4640	250664	379464
NY	951024	16190	43064	1874464
NC	464269	254129	7119	3310133
ND	974938	34882	126745	174863
OH	681914	255996	175516	1333752
OK	1934376	28967	52931	973831
OR	752894	12936	312190	560812
PA	862731	92830	73665	2661211
RI	5123	310	2748	27115
SC	271446	50011	742	676709
SD	1750098	228625	489489	465760
TN	1128827	120072	6922	804183
TX	5533533	74805	1527643	3405293
UT	406537	4129	433578	381712
VT	200135	978	8790	437553
VA	788333	56000	103170	1357854
WA	548334	9380	43164	1089611
WV	231709	4669	66395	226613
WI	2087907	215460	69644	2042733
WY	727892	4285	646172	118725

	BEET82	PCANE82	VEG82	VVEG82
AL	0	0	29680	10311
AZ	34.70	0	660000	191190
AR	0	0	20040	9137
CA	33.00	0	11464060	1720445
CO	35.00	0	236700	32325
CT	0	0	10100	2727
DE	0	0	61670	8258
FL	0	28.20	1164800	451565
GA	0	0	12200	5133
ID	37.20	0	324110	27674
IL	0	0	276400	28219
IN	0	0	160710	16096
IA	0	0	32300	1810
KS	31.40	0	0	0
KY	0	0	0	0
LA	0	25.10	2150	1492
ME	0	0	10950	2146
MD	0	0	127470	13384
MA	0	0	41150	13842
MI	35.80	0	608920	88587
MN	34.30	0	832250	68705
MS	0	0	0	0
MO	0	0	1750	280
MT	42.40	0	0	0
NE	34.90	0	0	0
NV	0	0	0	0
NH	0	0	0	0
NJ	0	0	256030	56612
NM	36.10	0	147410	28236
NY	0	0	710680	122623
NC	0	0	48680	8662
ND	35.70	0	0	0
OH	28.90	0	475380	56253
OK	0	0	4500	720
OR	36.30	0	920520	96831
PA	0	0	190900	32086
RI	0	0	0	0
SC	0	0	64280	36735
SD	0	0	0	0
TN	0	0	44770	16073
TX	36.70	19.50	562080	182677
UT	0	0	46000	3814
VT	0	0	0	0
VA	0	0	74800	20801
WA	0	0	801800	80282
WV	0	0	330	30
WI	0	0	1025520	95126
WY	38.80	0	0	0

	RES79	RES80	RES81	RES82
AL	13726	15115	17014	18346
AZ	11849	14435	16705	17809
AR	14904	15813	16713	18837
CA	63568	75084	87652	90000
CO	16269	17257	27125	29625
CT	3421	4652	4559	5419
DE	2301	3069	3527	3785
FL	34315	40725	45282	48298
GA	20364	22913	27841	31463
ID	7318	8328	10194	11585
IL	15281	16250	17830	19351
IN	21355	23658	27003	28343
IA	18941	21839	21229	23502
KS	16373	20766	24179	24720
KY	9843	11339	12429	13463
LA	19902	21971	25103	28259
ME	4685	5618	5723	5514
MD	6384	6644	6958	7489
MA	3865	3773	4821	5211
MI	20997	22793	18684	24798
MN	23492	25392	27594	29454
MS	16579	20114	23237	23991
MO	13503	15253	17498	17289
MT	8422	8576	9472	10621
NE	21302	24550	25971	27194
NV	3617	3885	4648	4172
NH	2054	2118	2514	2670
NJ	12348	13989	13606	11141
NM	3466	4027	3606	5310
NY	34077	34552	41155	39370
NC	29463	32257	35039	38443
ND	10052	13483	15189	16924
OH	19458	19835	19458	20466
OK	8004	10078	11788	11652
OR	16794	20038	19629	21365
PA	12580	13685	14688	15680
RI	2572	2719	2817	2854
SC	10772	12119	11715	11975
SD	6446	6342	7029	8401
TN	13703	15571	16378	14658
TX	29046	31562	36589	44966
UT	6769	7462	8196	8826
VT	2014	2257	2509	3025
VA	17972	19913	22343	23419
WA	17079	19052	20072	20581
WV	4060	4213	4497	4932
WI	24107	26191	28222	29133
WY	2869	2472	3837	5034

	RAIN82	W1	W2	W3	W4
AL	1.77	5.40	1.80	.10	106
AZ	-0.95	36.17	3.88	.50	83
AR	-2.62	4.26	1.42	.16	120
CA	-0.02	11.83	2.99	.20	125
CO	-0.11	17.68	3.08	.50	75
CT	-0.49	8.37	2.79	.17	120
DE	-1.20	3.87	1.29	.13	150
FL	1.21	8.91	2.97	.10	131
GA	0.46	6.39	2.13	.10	113
ID	1.36	11.75	3.24	.50	103
IL	2.41	3.60	1.20	.44	158
IN	1.46	4.17	1.39	.14	144
IA	3.78	4.02	1.34	.14	150
KS	-1.01	5.37	1.79	.35	117
KY	-0.76	3.78	1.26	.20	124
LA	3.51	5.07	1.69	.16	129
ME	0.00	7.20	2.40	.17	118
MD	-1.28	7.80	2.60	.13	137
MA	0.70	11.22	3.74	.17	126
MI	1.08	5.25	1.75	.12	122
MN	-0.17	4.17	1.39	.10	128
MS	4.89	6.51	2.17	.16	111
MO	1.33	4.38	1.46	.17	136
MT	-0.55	13.86	3.51	.50	64
NE	-1.18	4.53	1.51	.35	118
NV	-0.40	4.62	1.67	.50	108
NH	-0.10	15.54	5.18	1.0	106
NJ	-0.69	5.58	1.86	.13	139
NM	0.29	26.01	2.49	.50	62
NY	-0.38	7.86	2.62	.14	116
NC	2.23	5.67	1.89	.19	127
ND	-0.70	5.88	1.96	.70	99
OH	-1.64	4.65	1.55	.16	124
OK	-1.40	7.47	2.49	.90	104
OR	0.35	12.98	7.04	.20	114
PA	-0.98	5.31	1.77	.13	122
RI	-0.43	7.32	2.44	.17	130
SC	-1.93	7.95	2.65	.10	111
SD	1.06	4.23	1.41	.47	84
TN	1.34	4.53	1.51	.19	117
TX	0.57	7.07	2.34	.90	100
UT	1.85	12.60	3.67	.67	90
VT	-0.36	11.25	3.75	.17	104
VA	1.74	4.23	1.41	.19	99
WA	0.20	17.30	3.63	.20	88
WV	-2.68	5.55	1.85	.22	98
WI	-0.25	5.91	1.97	.11	117
WY	0.89	11.60	2.13	.50	109

	SOY82	COT82	TOB82	PEA82	HAY82
AL	36282726	420917	0	486985727	1109235
AZ	0	1126604	0	0	875036
AR	98397028	525535	0	0	1596000
CA	3073000	2871244	0	0	7656000
CO	0	0	0	0	3176000
CT	0	0	4244000	0	188363
DE	6373519	0	0	0	38149
FL	8521307	19600	18235391	138240737	718573
GA	51963741	192162	95134961	1378922483	1085492
ID	0	0	0	0	3836723
IL	335945066	0	0	0	2719971
IN	161396498	0	17447992	0	1837531
IA	291104402	0	0	0	6195569
KS	43026461	0	0	0	5090737
KY	44284557	0	538500570	0	2780784
LA	67574627	787192	0	0	733843
ME	0	0	0	0	414291
MD	11282161	0	37530000	0	531409
MA	0	0	887000	0	2378900
MI	34304408	0	0	0	3470998
MN	151240357	0	0	0	6623748
MS	81878805	1641208	0	0	1140876
MO	153658202	179134	5945000	0	5570149
MT	0	0	0	0	4287544
NE	70167278	0	0	0	6690768
NV	0	900	0	0	1206732
NH	0	0	0	0	163270
NJ	4006356	0	0	0	262317
NM	0	88162	0	19012569	936265
NY	0	0	0	0	5048698
NC	42230942	92202	689933042	399296866	643277
ND	8790196	0	0 0	4174406	
OH	124355051	0	26507582	0	2918896
OK	4630829	234932	0	159356344	3036924
OR	0	0	0	0	2475581
PA	3824408	0	22165316	0	4220181
RI	0	0	0	0	17708
SC	29001456	147510	119739105	27226476	411412
SD	22315029	0	0	0	6583721
TN	55263059	306006	155051519	0	1918410
TX	17730106	2712396	0	323596344	5668762
UT	0	0	0	0	1861807
VT	0	0	0	0	884975
VA	17688798	400	112423895	286813544	1708700
WA	0	0	0	0	2196160
WV	0	0	2848965	0	626265
WI	10616491	0	19993125	0	11836579
WY	0	0	0	0	1926331

	POT82	SUG82	CANE82	RICE82	SUN82
AL	2027479	0	0	0	0
AZ	1208966	234590	0	0	0
AR	19742	0	0	56823537	0
CA	17882146	4268924	0	36668230	0
CO	14777477	914722	0	0	0
CT	364624	0	0	0	0
DE	1332103	0	0	0	0
FL	6519791	0	10359951	0	0
GA	0	0	0	0	0
ID	89123212	3182000	0	0	0
IL	0	0	0	0	0
IN	908240	0	0	0	0
IA	287839	0	0	0	0
KS	144205	170000	0	0	0
KY	331344	0	0	0	0
LA	40085	0	7567760	23474718	0
ME	24521746	0	0	0	0
MD	396360	0	0	0	0
MA	732649	0	0	0	0
MI	12414828	1810556	0	0	0
MN	14146743	4665773	0	0	516667385
MS	34298	0	0	10106176	0
MO	0	0	0	3001855	0
MT	1892566	813230	0	0	0
NE	2004538	926000	0	0	0
NV	4608250	0	0	0	0
NH	41169	0	0	0	0
NJ	2069462	0	0	0	0
NM	391233	12000	0	0	0
NY	10284217	0	0	0	0
NC	2332493	0	0	0	0
ND	17094510	2527466	0	0	3242281818
OH	2316837	0	0	0	0
OK	237518	0	0	0	0
OR	20340634	264142	0	0	0
PA	4416296	0	0	0	0
RI	703350	0	0	0	0
SC	0	0	0	0	0
SD	1316143	0	0	0	471785327
TN	271401	0	0	0	0
TX	0	556000	1130000	24684721	294000000
UT	1412284	0	0	0	0
VT	76037	0	0	0	0
VA	0	0	0	0	0
WA	46075295	0	0	0	0
WV	126424	0	0	0	0
WI	21105958	0	0	0	0
WY	1127020	856162	0	0	0

	PEACH82	GRAPE82	APP82
AL	15000000	0	0
AZ	0	30200000	0
AR	32000000	21000000	10000000
CA	415000000	9988421861	480000000
CO	11000000	0	40000000
CT	2300000	0	0
DE	1700000	0	14500000
FL	0	0	0
GA	106284637	0	15000000
ID	7000000	0	126000000
IL	0	0	72827852
IN	0	0	63957015
IA	0	0	11500000
KS	1800000	0	12500000
KY	0	0	12000000
LA	5000000	0	0
ME	0	0	0
MD	17000000	0	79035306
MA	1500000	0	0
MI	50000000	94862025	915575438
MN	0	0	25000000
MS	3500000	0	0
MO	4500000	5000000	45000000
MT	0	0	0
NE	0	0	0
NV	0	0	0
NH	0	0	0
NJ	76778583	0	98140548
NM	0	0	12000000
NY	12000000	310591800	1007917514
NC	2000000	9000000	170000000
ND	0	0	0
OH	300000	18000000	130906261
OK	9000000	0	0
OR	13000000	0	150000000
PA	90000000	94000000	486332055
RI	0	0	0
SC	144099392	4800000	6000000
SD	0	0	0
TN	10000000	0	4500000
TX	24000000	0	0
UT	12000000	0	31312081
VT	0	0	0
VA	30000000	0	380683787
WA	20000000	275747308	2659230104
WV	18000000	0	251076732
WI	0	0	67106914
WY	0	0	0

	CHICK82	VCHICK82	BRO82	PBRO82
AL	63165	6001	1950905	25
AZ	859	36	0	0
AR	115154	13128	2473439	27
CA	85150	5620	786780	33
CO	6638	730	0	0
CT	15582	1247	0	0
DE	6768	711	817875	30
FL	34937	2655	398709	25
GA	107334	2880	2442940	25
ID	2484	149	0	0
IL	13630	1159	0	0
IN	60896	5542	0	0
IA	26504	2332	19800	36
KS	7098	639	0	0
KY	6061	545	8721	25
LA	13317	1252	0	0
ME	29040	2323	0	0
MD	17716	1949	1095413	30
MA	4457	357	0	0
MI	20326	1728	4720	27
MN	36202	2715	106650	25
MS	34889	3698	1224207	27.5
MO	36255	3263	0	0
MT	3474	208	0	0
NE	5712	514	7800	41
NV	37	2	0	0
NH	2787	223	0	0
NJ	3759	376	0	0
NM	2481	124	0	0
NY	29917	2004	2451	28
NC	68050	9323	1758204	24
ND	2681	161	0	0
OH	52593	5049	54000	24
OK	9359	1217	194446	27.5
OR	7904	533	72000	34.5
PA	93647	16856	471045	27
RI	1295	104	0	0
SC	22739	2228	182297	25.5
SD	3809	229	0	0
TN	12214	1099	0	0
TX	44695	4916	890000	29
UT	3666	198	0	0
VT	1172	94	0	0
VA	18341	1926	588302	25.5
WA	18517	1111	93762	32.5
WV	4081	355	94104	28.5
WI	12025	1106	48930	26
WY	202	11	972426	26.5

	TURK82	PTURK82	EGG82	PEGG82
AL	0	0	2879	74.5
AZ	0	0	114	50.5
AR	236600	37	4064	63.3
CA	404000	39	8288	52.6
CO	107316	35	627	60.0
CT	518	70	1057	88.0
DE	5093	40	137	78.5
FL	0	0	2963	49.6
GA	62176	41	5419	67.2
ID	0	0	238	56.0
IL	5966	41	1158	58.0
IN	117761	48	4464	56.0
IA	172890	38	1985	46.6
KS	4242	34	462	48.9
KY	0	0	484	54.4
LA	0	0	457	69.4
ME	0	0	1430	78.3
MD	1773	40	658	78.0
MA	3089	77	314	84.0
MI	36400	41	1525	51.0
MN	443300	39	2432	49.5
MS	0	0	1524	67.9
MO	236400	36	1456	50.6
MT	0	0	188	55.0
NE	13514	35	809	41.8
NV	0	0	2	51.9
NH	440	83	147	83.0
NJ	1418	82	276	65.0
NM	0	0	302	60.0
NY	5660	39	1859	55.5
NC	477900	41	3065	66.3
ND	17100	39	102	37.0
OH	57780	40	2755	51.0
OK	39045	37	814	71.0
OR	19845	48	620	56.8
PA	100700	47	4324	58.0
RI	0	0	74	81.5
SC	60691	38	1656	56.7
SD	36640	39	428	36.5
TN	0	0	879	63.3
TX	104000	39	3113	69.0
UT	54090	48	439	50.0
VT	0	0	79	93.0
VA	183474	39	929	69.3
WA	0	0	1334	54.2
WV	34686	39	142	70.5
WI	131255	36	991	46.0
WY	0	0	9	54.4

	FARM82	VLAND82	LAND82	PAS82	IRR82
AL	48418	8241977	3252622	1466844	65422
AZ	7254	7498378	1009346	121857	1053944
AR	50504	14417020	7471846	2053440	2020656
CA	82383	60818035	8752193	1340224	8440008
CO	27063	15038554	6032159	994437	3170510
CT	3749	1182005	170232	41996	6695
DE	3338	1217847	499986	12374	44168
FL	36314	19982140	2638753	1066927	1562140
GA	49598	11128815	4754130	1287206	574760
ID	24610	11119350	4877178	761347	3424233
IL	98467	53023933	22999221	1068318	166012
IN	77151	26089709	12126822	795087	131830
IA	115369	54305573	24125362	2498558	91427
KS	73280	28040193	20181839	3230078	2674908
KY	101623	14632237	4830448	3450089	22678
LA	31588	12015926	4688754	908732	693336
ME	6998	1048270	456651	86473	5831
MD	16165	5266785	1524574	195513	38452
MA	5384	1098191	195765	51108	17308
MI	58642	13366236	7249972	564614	285784
MN	94372	32310809	19719580	1206126	315366
MS	42393	10890452	5791266	1438659	430033
MO	112419	25064011	12718691	5583967	402864
MT	23471	15216232	9318109	1113862	1995501
NE	60209	31744820	17058333	2394476	6029966
NV	2697	2176034	586171	182420	797243
NH	2757	201171	116613	30658	0
NJ	8259	2811412	566425	63723	83029
NM	13421	6839524	1224243	442776	730136
NY	42175	7467027	4422780	889647	52036
NC	72751	13609307	4643631	801295	79773
ND	36406	17407544	20288977	1572322	161667
OH	86897	23220435	10380274	978114	0
OK	72481	22509852	8952816	3855764	490492
OR	34039	12518281	3300075	851008	1796380
PA	55498	12490814	4352801	860149	18128
RI	728	172876	21252	4632	2224
SC	24916	5161424	2468180	481866	79936
SD	37052	14573117	14424258	2304521	373920
TN	90540	12546940	4540293	2602673	17719
TX	184945	71160515	20714523	10017869	5570680
UT	13932	5348665	1110714	470011	1059449
VT	6315	206616	547848	205499	0
VA	51829	10583245	2772963	1520424	42801
WA	36047	14616532	5269554	610335	1634067
WV	18722	2401622	572916	673489	945
WI	82173	19076564	10052953	1227822	259258
WY	8820	6176627	1808934	459211	1557117

	PA82	OP182	OP282	OP382	OP482
AL	40124	14756	3455	4238	22073
AZ	48374	2522	614	660	2938
AR	167388	18799	3941	4551	18452
CA	130418	29585	7392	8401	31575
CO	231261	10672	3139	2511	8384
CT	125	1457	277	321	1431
DE	663	1367	255	245	1129
FL	7950	12592	2598	2896	15532
GA	45010	17065	3753	3826	20146
ID	143434	10000	2846	2285	7384
IL	173266	42417	12153	7496	27903
IN	91755	27333	7303	6425	30313
IA	415341	55937	16394	6835	25231
KS	896640	30507	8645	5562	21301
KY	19629	33915	10502	9049	38657
LA	101046	10859	2746	3659	11307
ME	1108	2605	730	735	2466
MD	3467	6247	1414	1385	5873
MA	103	2109	472	585	1838
MI	85139	21336	5017	5380	23178
MN	402053	44798	11286	7666	21333
MS	130954	14240	3474	4039	16744
MO	138981	41570	10582	9690	41184
MT	503862	10921	2915	1911	5242
NE	538569	30763	7921	3246	10758
NV	3696	1018	300	303	887
NH	0	923	293	326	1031
NJ	1595	3081	589	923	3074
NM	79220	4436	1529	1513	4733
NY	29257	19440	3336	3456	13084
NC	28333	27550	7031	5550	24712
ND	1156527	19113	5767	2470	4809
OH	53550	30097	8025	7408	35408
OK	413455	22324	5977	6934	30957
OR	64820	10888	3269	3720	14101
PA	13457	21936	5319	5196	18945
RI	0	271	58	56	299
SC	23598	8378	2030	2023	10118
SD	395700	19515	5314	2000	5598
TN	36935	27737	7838	7845	39273
TX	1440931	57244	16532	16598	80023
UT	17907	4057	1240	1461	6195
VT	0	3019	617	535	1707
VA	12471	17968	4541	4367	20641
WA	215283	13049	3140	3667	13933
WV	1174	5786	1529	1866	8345
WI	85199	43124	7821	5418	20197
WY	18403	3767	1016	753	2490

	FERT82	CHEM82	LAB82	CONL82	CUST82
AL	109986	62768	86286	6503	20305
AZ	58583	58480	151176	30686	43434
AR	130760	114176	164381	7807	39517
CA	427510	468305	1817353	413575	306407
CO	77584	32937	128443	11193	43402
CT	7504	3365	44115	1462	1481
DE	19993	10868	17893	1296	2606
FL	216837	165227	479467	201289	89464
GA	199429	111431	149003	14181	32707
ID	160362	52518	146865	18710	38054
IL	712486	344472	225139	8024	83511
IN	453266	173836	150806	8000	40588
IA	562376	331747	221547	8358	124706
KS	254498	94917	153240	8123	104869
KY	135511	56988	165749	11809	25868
LA	94609	116917	106362	4249	25825
ME	18705	9848	44879	3436	2416
MD	71929	27286	68146	4473	10337
MA	7102	4862	42765	2598	3514
MI	241914	114084	185819	14445	30383
MN	374756	223974	207152	9127	77201
MS	114244	140001	136900	4714	35446
MO	255441	130046	140652	9231	53314
MT	79624	43241	83378	6000	30817
NE	324613	140896	165634	7752	82429
NV	5381	2795	20259	1115	4717
NH	2711	1338	13305	578	672
NJ	26014	14409	62043	11632	3983
NM	14914	7946	59172	8905	9847
NY	109288	56010	243703	12778	20082
NC	237587	111252	243429	20744	35892
ND	158947	116766	76522	3961	43872
OH	356905	139727	164914	9582	37765
OK	116198	31006	97342	11855	61817
OR	104513	56667	179035	14694	25244
PA	127444	47301	222586	12183	26540
RI	1125	647	5559	118	164
SC	97537	58993	79165	9581	11040
SD	79714	53789	66954	3322	56653
TN	124677	57734	108061	8187	20708
TX	366312	207456	477185	88291	181086
UT	10241	5225	41628	3376	7190
VT	8897	2010	28734	435	1934
VA	115686	50117	126189	10335	16001
WA	173892	102172	312525	33501	37740
WV	10094	4974	19864	2369	1804
WI	262263	89943	278520	9946	52370
WY	17728	6291	40375	4135	8919

	AGE182	AGE282	AGE382	AGE482	AGE582
AL	768	5209	9548	11408	11876
AZ	58	758	1729	1874	1754
AR	947	5816	10640	12118	12117
CA	819	7869	17691	19711	21546
CO	660	3572	5448	6272	6443
CT	61	356	768	820	934
DE	114	404	650	768	816
FL	337	3401	7262	8863	9256
GA	769	5255	10279	11392	12085
ID	599	3549	5283	5573	5754
IL	4128	14910	18615	21442	24457
IN	2747	11625	16234	17260	17496
IA	5602	20342	22538	26092	27581
KS	2840	10661	12224	14808	17735
KY	3115	13747	21015	21878	21821
LA	741	4037	6546	7339	7199
ME	96	871	1739	1700	1505
MD	366	1749	3284	3673	3981
MA	64	680	1156	1116	1254
MI	1630	7871	13272	13417	13352
MN	4482	17067	19583	21427	21285
MS	636	4575	7937	9442	10520
MO	3606	14222	21540	24513	25915
MT	514	3144	4668	5349	5845
NE	3106	10324	10471	12934	14599
NV	33	254	592	664	684
NH	28	319	634	644	636
NJ	171	747	1688	1964	2091
NM	232	1481	2588	3168	3195
NY	845	5378	9360	9996	9962
NC	1635	8564	13438	16250	18473
ND	1974	6840	6769	7847	8589
OH	2976	12214	17853	19134	20184
OK	1746	8031	13760	16312	17263
OR	453	4035	8082	7984	7823
PA	1358	7513	11579	12940	12999
RI	7	78	144	166	185
SC	325	2524	4706	5608	6479
SD	1811	6446	6192	8025	9327
TN	1922	9592	17578	20138	21019
TX	3340	18686	32330	41931	46983
UT	201	1501	2541	3498	3422
VT	111	906	1536	1491	1322
VA	831	5079	9290	11369	12773
WA	428	4415	8555	8600	8490
WV	213	1715	3472	4002	4509
WI	2596	13406	17494	19049	18834
WY	173	1163	1785	1963	2122

	AGE682	VSOLD82	LPP82	VFEED82	SEED82
AL	9609	1698399	203265	466615	38683
AZ	1081	1487450	249003	234904	13245
AR	8866	2823440	272282	570214	67413
CA	14747	12476763	854513	1716853	164852
CO	4668	2937339	987338	496508	43220
CT	810	284582	24943	66617	4748
DE	586	370562	37202	140508	6964
FL	7195	3514156	163144	348011	54615
GA	9818	2763788	251232	659424	63217
ID	3852	2226494	325991	232596	58629
IL	14915	7309169	446584	476686	292233
IN	11789	4221211	299782	521701	154222
IA	13214	9823180	1535643	1213628	312929
KS	15012	6188378	1899254	919738	83478
KY	20047	2373334	210452	182471	48455
LA	5726	1400808	64005	168361	60057
ME	1087	399286	20717	100879	9209
MD	3112	1027164	98141	274994	22334
MA	1114	280087	11452	46925	5979
MI	9100	2585201	169533	254266	105102
MN	10528	5937477	557379	771004	204980
MS	9283	1915468	134059	288265	48968
MO	22623	3603722	383086	592831	97713
MT	3951	1536501	164208	110169	20786
NE	8775	6617238	1759291	842838	151865
NV	470	198794	28373	29077	3704
NH	484	101074	3987	25108	1260
NJ	1598	432966	13562	32933	14473
NM	2757	824418	225535	140861	7592
NY	6634	2419528	95325	442863	56784
NC	14391	3489931	228905	700414	63282
ND	4387	2292027	103507	72741	92138
OH	14536	3380208	243872	391520	139681
OK	15369	2524991	625430	395070	34894
OR	5662	1638032	159640	192521	32563
PA	9109	2841235	260823	602460	56345
RI	148	30376	1271	5347	1021
SC	5274	965477	53529	141047	21375
SD	5251	2476044	445797	268611	68235
TN	20221	1678356	127454	227054	40294
TX	41675	8881220	2333249	1549538	164346
UT	2769	551901	79650	107827	6416
VT	941	368715	16151	103716	2851
VA	12487	1603167	161341	294993	32353
WA	5559	2825875	347037	347621	55508
WV	4811	239688	29797	51512	3162
WI	10794	4850010	261546	666896	117445
WY	1614	604715	143648	64830	6572

	E82	G82	DF82	LPG82	FO82
AL	112904	35149	38366	13492	640
AZ	106558	18561	23604	3328	121
AR	230310	54991	91861	25607	441
CA	739321	166182	184451	27954	2361
CO	182638	53802	49583	8642	481
CT	20598	5373	2591	1084	4288
DE	18092	5192	5019	1465	975
FL	172843	51667	62251	9941	2000
GA	187859	52731	68876	22653	866
ID	171340	56183	50148	3222	646
IL	566561	178145	206280	59243	3825
IN	329120	99213	108282	41731	5995
IA	668021	186746	203756	107883	5131
KS	412581	127136	155682	22588	899
KY	164229	64905	50638	5343	1773
LA	138846	34715	67777	6965	448
ME	26396	9194	5397	467	3000
MD	61114	18778	16278	4184	2819
MA	22858	6698	2443	753	4972
MI	228394	70655	70934	16046	2857
MN	533461	154989	158621	76753	5787
MS	163503	39976	73566	16905	512
MO	306793	118629	101683	18510	1100
MT	156694	65507	54248	5563	1668
NE	472722	130167	165675	50306	2355
NV	22791	7590	5140	1058	300
NH	8998	2500	1406	294	1067
NJ	36954	12704	7006	1766	4590
NM	64808	18847	12958	6184	263
NY	201276	62117	48820	7741	11300
NC	277375	74212	68731	59533	16540
ND	285160	100623	120422	16067	2803
OH	282239	87804	91901	20944	5116
OK	209316	65337	76315	19718	461
OR	120844	44054	33027	2158	1618
PA	200532	61510	41427	9617	13118
RI	2375	782	501	65	354
SC	85156	25653	30027	9199	3637
SD	256400	91391	89388	19001	2453
TN	127675	46738	46640	3400	1372
TX	728490	185399	232449	51054	1839
UT	48407	17714	12371	1458	294
VT	25284	7346	6108	414	1068
VA	121084	42145	31030	13420	5272
WA	171489	56633	54067	3397	1564
WV	20003	8199	4118	1066	376
WI	382134	121710	89441	26204	4089
WY	53466	24035	13326	3294	192

	MACH82	PAST82
AL	1162279	3851344
AZ	386571	15317084
AR	1786634	4792448
CA	3862916	19920639
CO	1387724	21765697
CT	126759	94225
DE	153587	31792
FL	1081447	8082259
GA	1530441	3221161
ID	1449300	6116858
IL	6088342	2628520
IN	3459843	1754353
IA	6727793	4979835
KS	3828485	17537645
KY	2229687	5562290
LA	1366858	2411119
ME	236113	208795
MD	658072	375085
MA	151758	118024
MI	2674025	1083654
MN	5719009	3448253
MS	1482361	3811766
MO	3411671	11884042
MT	1562293	39024982
NE	4080265	22953235
NV	141287	7909432
NH	76129	1000000
NJ	298051	116486
NM	415976	36771488
NY	2000708	2077871
NC	2091984	1852557
ND	3058930	10295089
OH	3414418	2313410
OK	2320958	20560444
OR	1253064	11718524
PA	2136919	1685848
RI	18824	11062
SC	758251	1137010
SD	2246276	20755514
TN	1866062	4785769
TX	5591880	100918470
UT	469815	6605828
VT	274145	5000000
VA	1392275	3579504
WA	1647885	5760101
WV	298814	1795475
WI	4405606	3366729
WY	462012	27207535

	PRICE82	PSUN82	PSOY82
AL	0	0	5.35
AZ	0	0	0
AR	7.87	0	5.70
CA	7.87	0	0
CO	0	0	0
CT	0	0	0
DE	0	0	5.60
FL	0	0	5.45
GA	0	0	5.45
ID	0	0	0
IL	0	0	5.65
IN	0	0	5.40
IA	0	0	5.45
KS	0	0	5.25
KY	0	0	5.60
LA	7.87	0	5.65
ME	0	0	0
MD	0	0	5.50
MA	0	0	0
MI	0	0	5.35
MN	0	8.68	5.40
MS	7.87	0	5.55
MO	7.87	0	5.35
MT	0	0	0
NE	0	0	5.35
NV	0	0	0
NH	0	0	0
NJ	0	0	5.30
NM	0	0	0
NY	0	0	0
NC	0	0	5.60
ND	0	8.66	5.35
OH	0	0	5.45
OK	0	0	5.00
OR	0	0	0
PA	0	0	5.00
RI	0	0	0
SC	0	0	5.60
SD	0	8.62	5.25
TN	0	0	5.50
TX	7.87	8.85	5.10
UT	0	0	0
VT	0	0	0
VA	0	0	5.60
WA	0	0	0
WV	0	0	0
WI	0	0	5.25
WY	0	0	0

	PRICE81	PSUN81	PSOY81
AL	0	0	6.08
AZ	0	0	0
AR	9.05	0	6.17
CA	9.05	0	0
CO	0	0	0
CT	0	0	0
DE	0	0	6.25
FL	0	0	6.20
GA	0	0	6.09
ID	0	0	0
IL	0	0	6.15
IN	0	0	6.08
IA	0	0	5.88
KS	0	0	5.80
KY	0	0	6.33
LA	9.05	0	6.37
ME	0	0	0
MD	0	0	6.15
MA	0	0	0
MI	0	0	6.02
MN	0	11.00	5.77
MS	9.05	0	6.21
MO	9.05	0	6.01
MT	0	0	0
NE	0	0	5.75
NV	0	0	0
NH	0	0	0
NJ	0	0	5.96
NM	0	0	0
NY	0	0	0
NC	0	0	6.13
ND	0	10.70	5.66
OH	0	0	6.18
OK	0	0	5.70
OR	0	0	0
PA	0	0	5.99
RI	0	0	0
SC	0	0	6.17
SD	0	10.90	5.67
TN	0	0	6.06
TX	9.05	12.90	5.10
UT	0	0	0
VT	0	0	0
VA	0	0	5.60
WA	0	0	0
WV	0	0	0
WI	0	0	5.25
WY	0	0	0

	PAP82	PGRA82	QOR81	QGF81	POR81	PGF81
AL	0	0	0	0	0	0
AZ	0	991.0	97500	89600	103.20	122.50
AR	15.1	238.0	0	0	0	0
CA	11.2	230.0	2446875	257920	119.20	143.13
CO	10.3	0	0	0	0	0
CT	16.1	0	0	0	0	0
DE	9.8	0	0	0	0	0
FL	0	0	7758000	2137750	125.33	115.29
GA	10.8	473.0	0	0	0	0
ID	16.1	0	0	0	0	0
IL	13.3	0	0	0	0	0
IN	13.8	0	0	0	0	0
IA	14.5	0	0	0	0	0
KS	13.5	0	0	0	0	0
KY	15.4	0	0	0	0	0
LA	0	0	0	0	0	0
ME	14.5	0	0	0	0	0
MD	13.7	0	0	0	0	0
MA	17.3	0	0	0	0	0
MI	6.9	259.0	0	0	0	0
MN	19.0	0	0	0	0	0
MS	0	0	0	0	0	0
MO	15.0	320.0	0	0	0	0
MT	0	0	0	0	0	0
NE	0	0	0	0	0	0
NV	0	0	0	0	0	0
NH	15.5	0	0	0	0	0
NJ	10.3	230.0	0	0	0	0
NM	12.4	0	0	0	0	0
NY	8.9	233.0	0	0	0	0
NC	8.1	321.0	0	0	0	0
ND	0	0	0	0	0	0
OH	13.5	203.0	0	0	0	0
OK	0	0	0	0	0	0
OR	10.0	0	0	0	0	0
PA	9.3	225.0	0	0	0	0
RI	16.0	0	0	0	0	0
SC	11.4	289.0	0	0	0	0
SD	0	0	0	0	0	0
TN	17.7	0	0	0	0	0
TX	0	0	184025	268000	110.59	101.75
UT	12.9	0	0	0	0	0
VT	14.7	0	0	0	0	0
VA	9.7	0	0	0	0	0
WA	9.5	185.0	0	0	0	0
WV	9.4	0	0	0	0	0
WI	13.5	0	0	0	0	0
WY	0	0	0	0	0	0

	QOR77	QOR78	POR77	POR78	QGF77	QGF78	PGF77	PGF78
ALABAMA	0	0	0	0	0	0	0	0
ARIZONA	148125	135750	66.40	141.87	96000	96000	47.19	41.88
ARKANSAS	0	0	0	0	0	0	0	0
CALIFORNIA	1698750	1597500	79.20	156.53	246400	267520	65.94	108.75
COLORADO	0	0	0	0	0	0	0	0
CONNECTICUT	0	0	0	0	0	0	0	0
DELAWARE	0	0	0	0	0	0	0	0
FLORIDA	8406000	7551000	61.78	119.78	2188750	2184500	55.76	63.06
GEORGIA	0	0	0	0	0	0	0	0
IDAHO	0	0	0	0	0	0	0	0
ILLINOIS	0	0	0	0	0	0	0	0
INDIANA	0	0	0	0	0	0	0	0
IOWA	0	0	0	0	0	0	0	0
KANSAS	0	0	0	0	0	0	0	0
KENTUCKY	0	0	0	0	0	0	0	0
LOUISIANA	0	0	0	0	0	0	0	0
MAINE	0	0	0	0	0	0	0	0
MARYLAND	0	0	0	0	0	0	0	0
MASSACHUSETTS	0	0	0	0	0	0	0	0
MICHIGAN	0	0	0	0	0	0	0	0
MINNESOTA	0	0	0	0	0	0	0	0
MISSISSIPPI	0	0	0	0	0	0	0	0
MISSOURI	0	0	0	0	0	0	0	0
MONTANA	0	0	0	0	0	0	0	0
NEBRASKA	0	0	0	0	0	0	0	0
NEVADA	0	0	0	0	0	0	0	0
NEW-HAMPSHIRE	0	0	0	0	0	0	0	0
NEW-JERSEY	0	0	0	0	0	0	0	0
NEW-MEXICO	0	0	0	0	0	0	0	0
NEW-YORK	0	0	0	0	0	0	0	0
NORTH-CAROLINA	0	0	0	0	0	0	0	0
NORTH-DAKOTA	0	0	0	0	0	0	0	0
OHIO	0	0	0	0	0	0	0	0
OKLAHOMA	0	0	0	0	0	0	0	0
OREGON	0	0	0	0	0	0	0	0
PENNSYLVANIA	0	0	0	0	0	0	0	0
RHODE-ISLAND	0	0	0	0	0	0	0	0
SOUTH-CAROLINA	0	0	0	0	0	0	0	0
SOUTH-DAKOTA	0	0	0	0	0	0	0	0
TENNESSEE	0	0	0	0	0	0	0	0
TEXAS	293250	259250	46.59	98.35	496000	476000	43.50	39.50
UTAH	0	0	0	0	0	0	0	0
VERMONT	0	0	0	0	0	0	0	0
VIRGINIA	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	0	0	0	0
WEST-VIRGINIA	0	0	0	0	0	0	0	0
WISCONSIN	0	0	0	0	0	0	0	0
WYOMING	0	0	0	0	0	0	0	0

	BM77	AM77	BM78	AM78	PHAY78
ALABAMA	27.9	14.6	11.2	14.3	54.5
ARIZONA	2.4	3.0	4.1	2.6	60
ARKANSAS	12.6	10.1	15.2	9.6	40
CALIFORNIA	15.8	14.3	16.3	13.3	59.5
COLORADO	12.3	7.9	17.1	2.9	49.5
CONNECTICUT	3.5	1.5	2.5	1.9	73
DELAWARE	2.2	0.7	0.7	2.0	70
FLORIDA	43.2	16.5	9.7	10.8	57
GEORGIA	12.6	16.7	21.8	8.9	56.5
IDAHO	4.6	4.9	3.4	5.3	35.5
ILLINOIS	77.6	27.5	57.2	11.8	53
INDIANA	23.9	15.1	25.8	15.6	58.5
IOWA	23.4	17.7	22.2	15.4	42.5
KANSAS	48.4	13.6	41.9	9.2	45
KENTUCKY	11.3	19.3	24.6	13.8	49
LOUISIANA	12.7	7.5	11.3	8.0	43
MAINE	1.5	3.5	6.0	2.8	57
MARYLAND	7.6	9.1	8.3	13.2	70
MASSACHUSETTS	4.2	3.3	4.2	0.5	73
MICHIGAN	34.8	18.7	34.3	16.6	45.5
MINNESOTA	38.6	10.8	36.6	9.9	41
MISSISSIPPI	11.5	23.1	11.0	19.3	50
MISSOURI	64.0	4.6	61.8	6.8	45.5
MONTANA	0.6	1.0	6.7	7.9	43
NEBRASKA	32.2	7.3	9.6	4.7	34.5
NEVADA	1.1	1.4	1.1	1.4	52.5
NEW-HAMPSHIRE	2.7	1.9	3.1	1.3	69
NEW-JERSEY	14.3	6.0	13.4	4.1	75
NEW-MEXICO	7.2	7.6	8.3	8.5	64
NEW-YORK	38.0	27.9	30.6	18.5	57
NORTH-CAROLINA	48.3	34.5	36.2	29.1	64
NORTH-DAKOTA	32.1	2.5	8.6	3.2	36
OHIO	44.4	28.6	34.4	20.9	52.5
OKLAHOMA	24.2	10.5	14.6	8.9	56
OREGON	13.3	14.5	5.5	10.0	49
PENNSYLVANIA	28.1	20.6	24.5	21.4	62
RHODE-ISLAND	1.0	1.5	0.9	0.4	73
SOUTH-CAROLINA	47.4	16.1	32.2	14.1	56
SOUTH-DAKOTA	8.4	2.2	7.8	4.9	28.5
TENNESSEE	21.4	24.3	23.3	24.4	50
TEXAS	28.6	32.9	54.6	33.2	54
UTAH	3.1	3.4	1.7	2.4	47
VERMONT	9.6	3.3	4.4	2.0	65
VIRGINIA	9.9	9.9	32.9	15.9	65
WASHINGTON	9.7	4.7	6.9	6.1	47
WEST-VIRGINIA	5.6	7.5	1.4	5.0	47
WISCONSIN	33.9	18.3	22.7	14.0	37
WYOMING	2.4	1.7	2.1	1.5	48.5

	HFLABOR	CLABOR	CWMACH	MVME
ALABAMA	82493	5500	21092	1110772
ARIZONA	125966	29021	34002	342000
ARKANSAS	152123	7019	37303	1668191
CALIFORNIA	1371000	293829	228803	3083988
COLORADO	106621	11444	37004	1085388
CONNECTICUT	36449	973	1224	102028
DELAWARE	15051	1501	2435	142763
FLORIDA	387599	172922	70961	931330
GEORGIA	138960	12642	32048	1461844
IDAHO	108409	15114	33694	1285635
ILLINOIS	190946	5448	80820	5469887
INDIANA	115998	6925	38612	3163681
IOWA	191299	6670	117017	5819356
KANSAS	130434	7928	85391	3170065
KENTUCKY	114809	9672	25122	1952952
LOUISIANA	100613	4459	25650	1245297
MAINE	39418	2490	1972	217949
MARYLAND	53161	3665	9176	527186
MASSACHUSETTS	40287	1658	1690	126455
MICHIGAN	136398	12430	27150	2070588
MINNESOTA	157730	10617	68614	4618058
MISSISSIPPI	128454	5365	31479	1379340
MISSOURI	114795	9018	55284	2938773
MONTANA	70255	5982	28867	1254681
NEBRASKA	128028	8150	72986	3469455
NEVADA	18912	1019	3252	118318
NEW-HAMPSHIRE	12080	307	443	64077
NEW-JERSEY	55491	6579	4341	257632
NEW-MEXICO	50867	7071	7747	360543
NEW-YORK	183208	10074	18315	1616483
NORTH-CAROLINA	221729	21263	36903	1872894
NORTH-DAKOTA	70542	5590	39550	2598428
OHIO	138256	11244	35418	3019279
OKLAHOMA	79498	10588	52585	1783058
OREGON	138852	14236	27431	976332
PENNSYLVANIA	174513	10350	23227	1761936
RHODE-ISLAND	4573	78	115	15273
SOUTH-CAROLINA	79135	7893	14258	730797
SOUTH-DAKOTA	54239	3293	45068	1802247
TENNESSEE	80713	6965	20926	1632339
TEXAS	430935	86936	153519	4625915
UTAH	34067	3031	6217	368631
VERMONT	21322	658	1296	224345
VIRGINIA	105035	9779	18882	1119719
WASHINGTON	237622	22374	36854	1339581
WEST-VIRGINIA	16288	2153	1991	257473
WISCONSIN	180702	7315	41857	3506905
WYOMING	32179	4636	8105	370234

	TURK	PTURK
ALABAMA	0	0
ARIZONA	0	0
ARKANSAS	235000	45.0
CALIFORNIA	335600	43.6
COLORADO	91648	46.0
CONNECTICUT	804	70.0
DELAWARE	0	0
FLORIDA	0	0
GEORGIA	41197	39.6
IDAHO	0	0
ILLINOIS	8723	46.0
INDIANA	86583	37.2
IOWA	134569	43.8
KANSAS	2838	44.0
KENTUCKY	0	0
LOUISIANA	0	0
MAINE	118	62.0
MARYLAND	1793	45.7
MASSACHUSETTS	2993	68.0
MICHIGAN	30250	48.0
MINNESOTA	382494	42.4
MISSISSIPPI	0	0
MISSOURI	202650	43.5
MONTANA	0	0
NEBRASKA	9849	47.2
NEVADA	0	0
NEW-HAMPSHIRE	485	69.0
NEW-JERSEY	1270	60.0
NEW-MEXICO	0	0
NEW-YORK	3224	43.0
NORTH-CAROLINA	324289	43.0
NORTH-DAKOTA	13588	45.0
OHIO	64638	45.4
OKLAHOMA	22620	45.0
OREGON	24735	46.7
PENNSYLVANIA	62100	47.4
RHODE-ISLAND	210	68.0
SOUTH-CAROLINA	59132	40.7
SOUTH-DAKOTA	19972	41.4
TENNESSEE	57	42.0
TEXAS	146000	43.9
UTAH	63983	49.0
VERMONT	260	66.0
VIRGINIA	143573	41.6
WASHINGTON	0	0
WEST-VIRGINIA	34101	40.0
WISCONSIN	112979	45.0
WYOMING	0	0

	PEACH	GRAPE
ALABAMA	15	0
ARIZONA	0	28600000
ARKANSAS	37	16400000
CALIFORNIA	400	6785541236
COLORADO	5.5	0
CONNECTICUT	6.3	0
DELAWARE	2.3	0
FLORIDA	0	0
GEORGIA	120	0
IDAHO	11	0
ILLINOIS	16	0
INDIANA	5	0
IOWA	0	0
KANSAS	5	0
KENTUCKY	11	0
LOUISIANA	6.5	0
MAINE	0	0
MARYLAND	24	0
MASSACHUSETTS	3.5	0
MICHIGAN	60	118356478
MINNESOTA	0	0
MISSISSIPPI	4	0
MISSOURI	14	6600000
MONTANA	0	66000000
NEBRASKA	0	0
NEVADA	0	0
NEW-HAMPSHIRE	0	0
NEW-JERSEY	70	0
NEW-MEXICO	0	0
NEW-YORK	16	354004200
NORTH-CAROLINA	45	13600000
NORTH-DAKOTA	0	0
OHIO	5	24000000
OKLAHOMA	8.5	0
OREGON	13	0
PENNSYLVANIA	85	103000000
RHODE-ISLAND	0	0
SOUTH-CAROLINA	315	0
SOUTH-DAKOTA	0	0
TENNESSEE	8.4	0
TEXAS	48	0
UTAH	18	0
VERMONT	0	0
VIRGINIA	19	0
WASHINGTON	41	332374071
WEST-VIRGINIA	15	0
WISCONSIN	0	0
WYOMING	0	0

	WAGE	QFERT
ALABAMA	2.79	1066974
ARIZONA	3.39	302070
ARKANSAS	2.91	642876
CALIFORNIA	3.77	3921945
COLORADO	3.11	407937
CONNECTICUT	2.75	59963
DELAWARE	3.25	110430
FLORIDA	3.52	1998828
GEORGIA	2.70	2171534
IDAHO	3.18	608292
ILLINOIS	3.17	3622240
INDIANA	3.06	2791585
IOWA	3.03	3267725
KANSAS	3.39	1422811
KENTUCKY	2.79	986608
LOUISIANA	2.88	653773
MAINE	2.75	113330
MARYLAND	2.91	414178
MASSACHUSETTES	2.75	86503
MICHIGAN	3.07	1225687
MINNESOTA	2.97	1966306
MISSISSIPPI	2.81	791927
MISSOURI	2.87	1445212
MONTANA	2.49	249922
NEBRASKA	2.89	1802979
NEVADA	2.55	27361
NEW-HAMPSHIRE	2.75	24257
NEW-JERSEY	3.13	185020
NEW-MEXICO	2.57	111096
NEW-YORK	2.80	590726
NORTH-CAROLINA	2.61	1857027
NORTH-DAKOTA	3.41	647280
OHIO	2.94	1970945
OKLAHOMA	3.09	689760
OREGON	3.11	509234
PENNSYLVANIA	2.83	664379
RHODE-ISLAND	2.75	13678
SOUTH-CAROLINA	2.60	843712
SOUTH-DAKOTA	2.48	374847
TENNESSEE	2.72	797974
TEXAS	2.73	2523639
UTAH	2.75	110570
VERMONT	2.75	46043
VIRGINIA	2.59	789233
WASHINGTON	3.70	790185
WEST-VIRGINIA	2.45	65439
WISCONSIN	2.50	1442700
WYOMING	2.74	65585

	FEED	VFEED
ALABAMA	2548211	403665
ARIZONA	379835	53938
ARKANSAS	3356979	513997
CALIFORNIA	5570558	760939
COLORADO	709188	103209
CONNECTICUT	380944	56652
DELAWARE	673595	117503
FLORIDA	1751425	261085
GEORGIA	3509483	547919
IDAHO	351508	50955
ILLINOIS	1046637	204624
INDIANA	1487929	249968
IOWA	2491875	468422
KANSAS	1195176	173123
KENTUCKY	520537	83031
LOUISIANA	743641	110916
MAINE	753518	119324
MARYLAND	1199109	201597
MASSACHUSETTS	219258	33270
MICHIGAN	647388	109164
MINNESOTA	1835427	308322
MISSISSIPPI	1594798	267102
MISSOURI	1622830	250828
MONTANA	189904	27833
NEBRASKA	1092290	177272
NEVADA	78029	8788
NEW-HAMPSHIRE	132573	18876
NEW-JERSEY	151453	22982
NEW-MEXICO	295946	43253
NEW-YORK	2004557	294796
NORTH-CAROLINA	3117635	518042
NORTH-DAKOTA	152829	23308
OHIO	1017836	173793
OKLAHOMA	1012369	149753
OREGON	544744	80414
PENNSYLVANIA	2096341	335117
RHODE-ISLAND	26592	3861
SOUTH-CAROLINA	662373	104193
SOUTH-DAKOTA	387449	66871
TENNESSEE	867293	134273
TEXAS	3537929	523164
UTAH	392147	55673
VERMONT	453904	67039
VIRGINIA	1172177	189320
WASHINGTON	915316	125650
WEST-VIRGINIA	180902	30912
WISCONSIN	1539122	273474
WYOMING	95406	12582

	POTATO	BEETS	SUGAR	QRICE	QSUN
ALABAMA	2243225	0	0	0	0
ARIZONA	1725118	310066	0	0	0
ARKANSAS	29461	0	0	47947553	0
CALIFORNIA	16566841	4563144	0	25312483	0
COLORADO	13362049	1529147	0	0	0
CONNECTICUT	511229	0	0	0	0
DELAWARE	1269668	0	0	0	0
FLORIDA	5456561	0	10136254	0	0
GEORGIA	94510	0	0	0	0
IDAHO	96334487	2747264	0	0	0
ILLINOIS	323170	0	0	0	0
INDIANA	1183476	0	0	0	0
IOWA	199038	0	0	0	0
KANSAS	63940	423426	0	0	0
KENTUCKY	210027	0	0	0	0
LOUISIANA	140407	0	6788588	22439800	0
MAINE	25723427	0	0	0	0
MARYLAND	328467	0	0	0	0
MASSACHUSETTS	748993	0	0	0	0
MICHIGAN	10002744	1712060	0	0	0
MINNESOTA	18085699	4712581	0	0	845914201
MISSISSIPPI	36735	0	0	9160984	0
MISSOURI	93868	0	0	1298000	0
MONTANA	2088633	859950	0	0	0
NEBRASKA	1710939	1390304	0	0	0
NEVADA	4974289	0	0	0	0
NEW-HAMPSHIRE	74908	0	0	0	0
NEW-JERSEY	1831844	0	0	0	0
NEW-MEXICO	489473	37000	0	0	0
NEW-YORK	12106899	0	0	0	0
NORTH-CAROLINA	1925114	0	0	0	0
NORTH-DAKOTA	23544466	3040026	0	0	2018871463
OHIO	2372629	355656	0	0	0
OKLAHOMA	204814	0	0	0	0
OREGON	26801800	0	0	0	0
PENNSYLVANIA	5190271	0	0	0	0
RHODE-ISLAND	915056	0	0	0	0
SOUTH-CAROLINA	33831	0	0	0	0
SOUTH-DAKOTA	854026	0	0	0	147371497
TENNESSEE	192325	0	0	0	0
TEXAS	2946108	414000	1084039	27777490	170000000
UTAH	1319932	239040	0	0	0
VERMONT	126834	0	0	0	0
VIRGINIA	2477942	0	0	0	0
WASHINGTON	47099136	1647864	0	0	0
WEST-VIRGINIA	130803	0	0	0	0
WISCONSIN	17410238	0	0	0	0
WYOMING	996907	1016554	0	0	0

	INCOME	EXPENSE	VCOMMOD	VLIVE	VCROP
ALABAMA	2069.4	1155.0	1879142	1177029	702113
ARIZONA	1701.1	1108.1	1530579	771038	759541
ARKANSAS	3200.0	1605.8	2965978	1424757	1541221
CALIFORNIA	11287.6	6626.7	10596071	3401500	7194571
COLORADO	2879.2	2094.7	2642852	2088912	553940
CONNECTICUT	284.4	173.7	254880	145969	108911
DELAWARE	344.5	195.6	321486	216956	104530
FLORIDA	3602.2	1715.4	3437796	849558	2588238
GEORGIA	2887.8	1724.5	2625601	1466355	1159246
IDAHO	1776.2	1000.9	1506253	616469	889784
ILLINOIS	7090.1	3299.6	6556682	2127000	4429682
INDIANA	4210.8	2118.6	3456465	1551194	1905271
IOWA	9929.2	5338.3	8549180	5441752	3107428
KANSAS	5139.0	3261.2	4212147	2924753	1287394
KENTUCKY	2535.1	1058.7	2363738	1152690	1211048
LOUISIANA	1571.2	778.4	1469129	438559	1030570
MAINE	462.4	290.7	408291	288165	120126
MARYLAND	926.2	533.8	797563	521723	275840
MASSACHUSETTS	315.6	167.7	279555	114255	165300
MICHIGAN	2414.9	1224.9	2056257	984560	1071697
MINNESOTA	5713.7	2729.5	4933877	2590003	2343874
MISSISSIPPI	2205.1	1152.2	2055350	906099	1149251
MISSOURI	3978.2	1975.8	3487848	2125182	1362666
MONTANA	1506.9	735.8	1217817	684761	533056
NEBRASKA	5347.3	3430.0	4683444	3087575	1595869
NEVADA	195.5	130.3	178913	129587	49326
NEW-HAMPSHIRE	108.5	63.8	91101	66874	24227
NEW-JERSEY	432.6	249.1	398944	121759	277185
NEW-MEXICO	1064.5	713.9	972872	748307	224565
NEW-YORK	2177.6	1309.4	1912589	1338893	573696
NORTH-CAROLINA	3629.6	1697.3	3162536	1278620	1883916
NORTH-DAKOTA	2417.6	1067.9	1870009	526862	1343147
OHIO	3624.6	1864.0	3067440	1291691	1775749
OKLAHOMA	2542.3	1588.7	2320395	1666525	653870
OREGON	1473.4	833.3	1211061	420792	790269
PENNSYLVANIA	2473.8	1383.2	2148217	1488179	660038
RHODE-ISLAND	33.6	18.4	29140	12339	16801
SOUTH-CAROLINA	982.7	613.1	947404	373264	574140
SOUTH-DAKOTA	2369.0	1263.1	2073883	1512024	561859
TENNESSEE	1849.0	1006.8	1597260	872999	724261
TEXAS	8426.4	5485.9	7644352	4628470	3015882
UTAH	519.1	289.2	452817	350015	102802
VERMONT	354.2	184.0	312352	289167	23185
VIRGINIA	1537.4	794.4	1240599	710095	530504
WASHINGTON	2525.8	1218.0	2159471	633225	1526246
WEST-VIRGINIA	259.0	154.1	190005	139286	50719
WISCONSIN	4088.7	2046.0	3711798	2970923	740875
WYOMING	641.9	444.8	550658	469653	81005

	EDUC	EXT
ALABAMA	6316	14023547
ARIZONA	6563	4328956
ARKANSAS	6133	11305747
CALIFORNIA	7352	26615502
COLORADO	7420	7175773
CONNECTICUT	7957	2277896
DELAWARE	6396	1573367
FLORIDA	6699	11984825
GEORGIA	6260	19107699
IDAHO	7451	4730883
ILLINOIS	6941	15596321
INDIANA	7151	13302398
IOWA	7074	14457116
KANSAS	7244	13604830
KENTUCKY	5946	13011644
LOUISIANA	6200	13104613
MAINE	7528	3036141
MARYLAND	6797	7619839
MASSACHUSETTS	7810	5065843
MICHIGAN	6942	13535821
MINNESOTA	6470	13629222
MISSISSIPPI	6272	13238378
MISSOURI	6759	12885678
MONTANA	7202	4187729
NEBRASKA	6979	9893961
NEVADA	7719	2412833
NEW-HAMPSHIRE	7769	1984632
NEW-JERSEY	7503	7100773
NEW-MEXICO	6550	3716923
NEW-YORK	7261	22929506
NORTH-CAROLINA	5825	23281812
NORTH-DAKOTA	6531	4894490
OHIO	7113	16027914
OKLAHOMA	6924	10750470
OREGON	7560	8317540
PENNSYLVANIA	6860	13003756
RHODE-ISLAND	8180	1311457
SOUTH-CAROLINA	6145	10256750
SOUTH-DAKOTA	7990	4950923
TENNESSEE	5926	13314180
TEXAS	6645	31862173
UTAH	7712	3768548
VERMONT	7084	2464712
VIRGINIA	5875	19470446
WASHINGTON	7645	7690883
WEST-VIRGINIA	6262	5787274
WISCONSIN	6558	15708196
WYOMING	7606	2310841

	PCORN	PSORGH	PWHEAT	POAT	PBARLEY	PRICE	PSUN	PSOY
ALABAMA	2.30	2.24	3.00	1.40	0	0	0	6.70
ARIZONA	2.50	2.63	2.93	0	2.40	0	0	0
ARKANSAS	2.35	1.76	2.95	1.45	0	7.72	0	6.70
CALIFORNIA	2.75	2.46	3.25	1.60	2.35	7.72	0	0
COLORADO	2.10	1.76	2.75	1.20	2.35	0	0	0
CONNECTICUT	0	0	0	0	0	0	0	0
DELAWARE	2.25	0	2.95	0	1.80	0	0	6.50
FLORIDA	2.10	0	0	0	0	0	0	6.80
GEORGIA	2.45	1.82	2.95	1.30	0	0	0	6.40
IDAHO	2.35	0	3.08	1.45	1.95	0	0	0
ILLINOIS	2.15	1.79	3.05	1.25	1.75	0	0	6.65
INDIANA	2.15	1.79	3.00	1.55	0	0	0	6.75
IOWA	2.00	1.79	2.65	1.20	0	0	0	6.60
KANSAS	2.25	1.88	2.85	1.40	1.65	0	0	6.60
KENTUCKY	2.35	1.82	3.15	1.95	1.65	0	0	6.70
LOUISIANA	2.40	2.02	3.05	0	0	7.72	0	6.60
MAINE	0	0	0	1.05	0	0	0	0
MARYLAND	2.25	0	3.00	1.50	1.80	0	0	6.50
MASSACHUSETTS	0	0	0	0	0	0	0	0
MICHIGAN	2.10	0	3.35	1.25	2.60	0	0	6.70
MINNESOTA	1.90	0	2.85	1.10	1.80	0	11.50	6.55
MISSISSIPPI	2.65	2.16	2.95	0	0	7.72	0	6.70
MISSOURI	2.15	1.79	2.95	1.15	0	9.50	0	6.70
MONTANA	2.25	0	2.76	1.15	1.70	0	0	0
NEBRASKA	2.05	1.76	2.70	1.20	1.70	0	0	6.50
NEVADA	0	0	3.35	0	2.20	0	0	0
NEW-HAMPSHIRE	0	0	0	0	0	0	0	0
NEW-JERSEY	2.30	0	3.00	1.45	1.75	0	0	6.85
NEW-MEXICO	2.30	2.21	2.85	0	1.95	0	0	0
NEW-YORK	2.35	0	3.40	1.40	1.40	0	0	6.25
NORTH-CAROLINA	2.35	1.93	2.85	1.25	1.80	0	0	6.75
NORTH-DAKOTA	2.00	0	2.75	1.00	1.75	0	10.40	6.45
OHIO	2.15	0	3.20	1.35	1.75	0	0	6.75
OKLAHOMA	2.40	2.02	3.00	1.45	1.70	0	0	6.35
OREGON	2.65	0	3.45	1.40	1.90	0	0	0
PENNSYLVANIA	2.45	0	3.00	1.45	1.80	0	0	6.30
RHODE-ISLAND	0	0	0	0	0	0	0	0
SOUTH-CAROLINA	2.25	1.96	3.00	1.20	1.80	0	0	6.80
SOUTH-DAKOTA	1.80	1.51	2.76	1.05	1.70	0	10.30	6.50
TENNESSEE	2.30	2.21	2.85	1.75	1.95	0	0	6.50
TEXAS	2.40	2.10	2.95	1.30	1.90	7.72	10.40	6.25
UTAH	2.65	0	2.99	1.60	2.00	0	0	0
VERMONT	0	0	0	0	0	0	0	0
VIRGINIA	2.35	1.82	3.05	1.50	1.90	0	0	6.80
WASHINGTON	2.65	0	3.40	1.60	1.85	0	0	0
WEST-VIRGINIA	2.20	0	3.00	1.15	2.00	0	0	0
WISCONSIN	2.00	0	2.80	1.10	1.65	0	0	6.70
WYOMING	2.25	0	2.75	1.35	2.35	0	0	0

	CHICK	VCHICK	BROIL	PBROIL
ALABAMA	66041	8453	1634286	25.0
ARIZONA	1335	99	0	0
ARKANSAS	112328	13704	2203567	26.2
CALIFORNIA	78389	5487	575280	28.3
COLORADO	5408	541	0	0
CONNECTICUT	13784	1695	0	0
DELAWARE	3164	471	684643	26.0
FLORIDA	31768	2859	318572	24.8
GEORGIA	105444	15184	2021178	26.0
IDAHO	2332	198	0	0
ILLINOIS	16742	1339	0	0
INDIANA	51437	4784	54754	26.5
IOWA	25313	2101	29113	44.0
KANSAS	6269	940	0	0
KENTUCKY	7733	851	10900	25.0
LOUISIANA	15093	1856	287797	26.7
MAINE	31019	3815	369159	25.0
MARYLAND	7327	1018	905616	26.0
MASSACHUSETTS	8484	1044	0	0
MICHIGAN	22338	2457	5355	29.2
MINNESOTA	31335	1034	64930	30.2
MISSISSIPPI	38275	5894	1050555	27.0
MISSOURI	36465	5287	86440	26.7
MONTANA	2607	182	0	0
NEBRASKA	6766	453	5508	45.0
NEVADA	28	3	0	0
NEW-HAMPSHIRE	6575	809	0	0
NEW-JERSEY	4660	508	0	0
NEW-MEXICO	4051	284	0	0
NEW-YORK	32029	2370	0	0
NORTH-CAROLINA	72475	15582	1413920	25.9
NORTH-DAKOTA	2233	80	0	0
OHIO	38686	3482	87400	25.8
OKLAHOMA	9569	1531	134284	26.0
OREGON	6451	548	63550	31.0
PENNSYLVANIA	66232	13776	397220	27.3
RHODE-ISLAND	979	120	0	0
SOUTH-CAROLINA	19742	3218	140562	24.9
SOUTH-DAKOTA	6296	315	0	0
TENNESSEE	13065	1986	167088	25.0
TEXAS	39757	5208	773577	28.0
UTAH	2998	198	0	0
VERMONT	1485	183	0	0
VIRGINIA	18383	2592	393717	24.9
WASHINGTON	19073	1488	70733	30.8
WEST-VIRGINIA	3485	470	50211	29.0
WISCONSIN	18010	2846	44739	26.5
WYOMING	141	13	0	0

	PAPPLE	PGRAPES	PPEACH	PBEET	PSUGAR
ALABAMA	0	0	16.6	0	0
ARIZONA	0	943.00	0	25.0	0
ARKANSAS	10.9	247.00	12.5	0	0
CALIFORNIA	9.2	229.00	11.6	25.80	0
COLORADO	10.5	0	17.6	27.60	0
CONNECTICUT	13.6	0	29.0	0	0
DELAWARE	9.3	0	10.5	0	0
FLORIDA	0	0	0	0	20.50
GEORGIA	11.5	0	15.6	0	0
IDAHO	14.7	0	12.5	27.70	0
ILLINOIS	12.8	0	21.9	0	0
INDIANA	13.6	0	22.0	0	0
IOWA	13.8	0	0	0	0
KANSAS	11.1	0	17.6	21.50	0
KENTUCKY	12.6	0	20.0	0	0
LOUISIANA	0	0	20.0	0	18.90
MAINE	13.2	0	0	0	0
MARYLAND	10.4	0	13.3	0	0
MASSACHUSETTS	13.8	0	29.0	0	0
MICHIGAN	7.6	206.00	16.0	23.50	0
MINNESOTA	15.1	0	0	21.80	0
MISSISSIPPI	0	0	20.0	0	0
MISSOURI	15.3	231.00	16.0	0	0
MONTANA	0	0	0	29.90	0
NEBRASKA	0	0	0	27.80	0
NEVADA	0	0	0	0	0
NEW-HAMPSHIRE	13.4	0	0	0	0
NEW-JERSEY	11.3	0	23.6	0	0
NEW-MEXICO	9.7	0	0	25.30	0
NEW-YORK	8.5	245.00	18.5	0	0
NORTH-CAROLINA	7.9	300.00	16.0	0	0
NORTH-DAKOTA	0	0	0	22.90	0
OHIO	14.5	223.00	23.7	25.10	0
OKLAHOMA	0	0	14.2	0	0
OREGON	11.1	0	17.9	26.00	0
PENNSYLVANIA	8.9	232.00	15.8	0	0
RHODE-ISLAND	14.1	0	0	0	0
SOUTH-CAROLINA	11.7	0	15.5	0	0
SOUTH-DAKOTA	0	0	0	0	0
TENNESSEE	14.2	0	16.0	0	0
TEXAS	0	0	17.0	24.50	11.00
UTAH	11.0	0	17.0	29.00	0
VERMONT	12.8	0	0	0	0
VIRGINIA	7.8	0	14.3	0	0
WASHINGTON	12.3	209.00	14.4	26.80	0
WEST-VIRGINIA	8.7	0	17.8	0	0
WISCONSIN	12.1	0	0	0	0
WYOMING	0	0	0	29.50	0

	VEGI	VVEGI	MILK	VMILK
ALABAMA	93350	24077	635	78012
ARIZONA	605250	130453	890	101875
ARKANSAS	49650	11171	685	79704
CALIFORNIA	11118650	1659732	11787	1237728
COLORADO	287950	34102	826	101675
CONNECTICUT	16100	2286	601	72094
DELAWARE	82600	12266	126	14667
FLORIDA	2003950	506124	1930	249539
GEORGIA	191550	20392	1274	148350
IDAHO	307350	25479	1580	163463
ILLINOIS	390150	36441	2367	250152
INDIANA	322650	31805	2142	233699
IOWA	46650	2461	3917	407434
KANSAS	0	0	1362	150145
KENTUCKY	15200	2283	2183	239398
LOUISIANA	5050	2656	1037	123308
MAINE	8350	1587	623	74710
MARYLAND	188250	20827	1513	174790
MASSACHUSETTS	58600	9599	562	68526
MICHIGAN	633900	111995	4704	506141
MINNESOTA	784700	54818	8932	896175
MISSISSIPPI	63700	4483	817	93381
MISSOURI	26600	1663	2704	283452
MONTANA	0	0	283	31665
NEBRASKA	650	91	1219	130073
NEVADA	0	0	183	19696
NEW-HAMPSHIRE	0	0	322	38625
NEW-JERSEY	326850	66531	515	60323
NEW-MEXICO	116700	21508	444	54365
NEW-YORK	975150	120413	10263	1110159
NORTH-CAROLINA	219900	41012	1505	180205
NORTH-DAKOTA	0	0	880	87219
OHIO	637500	69659	4181	459135
OKLAHOMA	35050	3147	1055	121862
OREGON	851700	80963	1036	117789
PENNSYLVANIA	181000	24193	7771	889765
RHODE-ISLAND	0	0	53	6595
SOUTH-CAROLINA	177500	29208	496	61608
SOUTH-DAKOTA	150	21	1557	154720
TENNESSEE	51500	15543	2036	227056
TEXAS	1340100	236086	3400	402004
UTAH	56950	5531	915	98362
VERMONT	0	0	2139	244378
VIRGINIA	138650	22838	1849	210171
WASHINGTON	685750	90590	2651	292338
WEST-VIRGINIA	750	47	323	37771
WISCONSIN	1165400	94735	20729	2180455
WYOMING	0	0	110	12589

	CATTLE	VCATTLE	HOGS	VHOGS
ALABAMA	756295	335134	237292	107019
ARIZONA	629325	322611	42941	21642
ARKANSAS	689125	347363	114587	52710
CALIFORNIA	1622435	793460	61625	29765
COLORADO	1839120	937909	115400	53661
CONNECTICUT	21500	10259	3231	1454
DELAWARE	7240	3102	15554	7124
FLORIDA	564160	288150	91716	40355
GEORGIA	381560	177757	483167	212593
IDAHO	646490	335811	21006	9243
ILLINOIS	985385	478453	2401670	1114375
INDIANA	640785	292743	1463893	679246
IOWA	2889280	1465908	4939147	2321399
KANSAS	2668480	1397034	696027	327133
KENTUCKY	863380	410555	355012	164016
LOUISIANA	381110	184446	40819	17675
MAINE	21970	9813	2917	1313
MARYLAND	98625	44310	53373	24605
MASSACHUSETTS	18380	8072	17211	7745
MICHIGAN	502195	221997	236376	112515
MINNESOTA	1278425	560417	1439837	672404
MISSISSIPPI	539330	262172	102119	47792
MISSOURI	1966450	958240	1302899	609757
MONTANA	941570	515295	78602	35214
NEBRASKA	2899360	1452672	1164664	548557
NEVADA	165375	84487	2872	1410
NEW-HAMPSHIRE	12900	5524	3147	1416
NEW-JERSEY	29360	12065	15769	6938
NEW-MEXICO	591770	317412	20483	9811
NEW-YORK	294550	125068	44946	20181
NORTH-CAROLINA	271070	116431	700862	327303
NORTH-DAKOTA	677020	342735	96937	43912
OHIO	582700	284041	581030	275989
OKLAHOMA	1983070	990910	99716	46169
OREGON	477225	227738	32970	15265
PENNSYLVANIA	464364	213619	191429	88632
RHODE-ISLAND	1645	776	2858	1286
SOUTH-CAROLINA	162625	78709	154845	69835
SOUTH-DAKOTA	1567900	787151	584541	277072
TENNESSEE	712090	297154	399119	186389
TEXAS	5187690	2487868	316258	138521
UTAH	276710	135497	14791	6700
VERMONT	71010	29858	2882	1297
VIRGINIA	429210	189469	168249	76553
WASHINGTON	370140	180470	20597	9969
WEST-VIRGINIA	116540	52797	25951	11782
WISCONSIN	979675	416029	574389	263645
WYOMING	480025	270575	8504	3810

	SHEEP	VSHEEP	EGGS	PEGGS
ALABAMA	0	0	3329	62.8
ARIZONA	21210	10768	118	42.0
ARKANSAS	0	0	3998	52.0
CALIFORNIA	74769	42090	8412	46.0
COLORADO	69998	42963	535	50.0
CONNECTICUT	264	183	897	68.7
DELAWARE	0	0	129	67.9
FLORIDA	0	0	2954	42.7
GEORGIA	0	0	5662	60.7
IDAHO	38264	20221	206	46.0
ILLINOIS	12501	5933	1380	53.0
INDIANA	8865	4546	3447	52.1
IOWA	21597	12334	1914	38.8
KANSAS	13512	7654	511	41.8
KENTUCKY	1835	821	553	47.7
LOUISIANA	425	180	584	62.8
MAINE	622	371	1916	62.3
MARYLAND	1240	564	313	67.9
MASSACHUSETTS	340	212	341	66.2
MICHIGAN	8045	4801	1497	46.5
MINNESOTA	17953	10297	2189	41.5
MISSISSIPPI	0	0	1696	61.1
MISSOURI	7470	4023	1320	46.1
MONTANA	21756	11651	193	54.3
NEBRASKA	9234	5928	780	38.1
NEVADA	7260	4086	2.3	44.5
NEW-HAMPSHIRE	391	253	222	65.5
NEW-JERSEY	522	231	375	56.8
NEW-MEXICO	14350	9924	359	57.0
NEW-YORK	3147	1809	1845	46.5
NORTH-CAROLINA	373	153	3081	61.8
NORTH-DAKOTA	11899	6659	95	34.0
OHIO	20717	11111	2140	44.9
OKLAHOMA	5171	2757	612	59.0
OREGON	24443	13970	555	50.8
PENNSYLVANIA	3956	2546	3357	49.3
RHODE-ISLAND	0	0	51	65.6
SOUTH-CAROLINA	0	0	1409	53.2
SOUTH-DAKOTA	61502	33366	562	35.6
TENNESSEE	544	252	974	53.4
TEXAS	105395	57101	2630	60.8
UTAH	28550	16732	399	44.0
VERMONT	502	310	120	75.9
VIRGINIA	12519	6697	885	64.3
WASHINGTON	3358	2217	1121	46.8
WEST-VIRGINIA	7902	3983	153	61.5
WISCONSIN	6567	3457	973	43.7
WYOMING	49689	27132	17.5	50.2

	PPOT77
ALABAMA	9.30
ARIZONA	5.12
ARKANSAS	5.3
CALIFORNIA	5.77
COLORADO	2.88
CONNECTICUT	5.40
DELAWARE	4.22
FLORIDA	6.71
GEORGIA	6.7
IDAHO	2.95
ILLINOIS	3.00
INDIANA	4.56
IOWA	4.20
KANSAS	4.0
KENTUCKY	7.0
LOUISIANA	5.30
MAINE	3.36
MARYLAND	4.30
MASSACHUSETTS	5.40
MICHIGAN	4.14
MINNESOTA	2.77
MISSISSIPPI	5.80
MISSOURI	4.75
MONTANA	3.0
NEBRASKA	3.73
NEVADA	2.90
NEW-HAMPSHIRE	6.10
NEW-JERSEY	4.14
NEW-MEXICO	3.50
NEW-YORK	3.94
NORTH-CAROLINA	6.28
NORTH-DAKOTA	2.70
OHIO	4.34
OKLAHOMA	4.0
OREGON	2.89
PENNSYLVANIA	4.70
RHODE-ISLAND	3.90
SOUTH-CAROLINA	6.5
SOUTH-DAKOTA	3.05
TENNESSEE	7.75
TEXAS	7.88
UTAH	3.04
VERMONT	5.80
VIRGINIA	4.99
WASHINGTON	2.80
WEST-VIRGINIA	5.70
WISCONSIN	3.95
WYOMING	3.65

	PCOT78	PTOB78	PPEA78	PPOT78
ALABAMA	60.5	0	21.1	11.90
ARIZONA	59.6	0	0	8.15
ARKANSAS	60.5	0	0	5.7
CALIFORNIA	63.3	0	0	6.66
COLORADO	0	0	0	2.64
CONNECTICUT	0	0	0	5.90
DELAWARE	0	0	0	4.81
FLORIDA	60.0	144.0	21.3	6.21
GEORGIA	61.0	142.6	21.0	6.2
IDAHO	0	0	0	2.60
ILLINOIS	0	0	0	3.30
INDIANA	0	130.5	0	4.06
IOWA	0	0	0	4.50
KANSAS	0	0	0	4.2
KENTUCKY	0	131.5	0	4.2
LOUISIANA	60.2	0	0	5.70
MAINE	0	0	0	3.20
MARYLAND	0	131.0	0	4.83
MASSACHUSETTS	0	0	0	5.90
MICHIGAN	0	0	0	4.57
MINNESOTA	0	0	0	2.89
MISSISSIPPI	60.2	0	21.0	7.00
MISSOURI	60.6	127.0	0	4.0
MONTANA	0	0	0	3.00
NEBRASKA	0	0	0	4.03
NEVADA	60.0	0	0	3.00
NEW-HAMPSHIRE	0	0	0	6.0
NEW-JERSEY	0	0	0	3.90
NEW-MEXICO	64.1	0	22.0	5.00
NEW-YORK	0	0	0	4.34
NORTH-CAROLINA	65.4	131.5	22.0	6.29
NORTH-DAKOTA	0	0	0	2.70
OHIO	0	131.0	0	4.60
OKLAHOMA	53.9	0	21.2	4.2
OREGON	0	0	0	3.30
PENNSYLVANIA	0	120.0	0	4.70
RHODE-ISLAND	0	0	0	4.25
SOUTH-CAROLINA	63.3	137.6	21.1	6.3
SOUTH-DAKOTA	0	0	0	3.08
TENNESSEE	61.8	130.2	0	7.15
TEXAS	54.6	0	20.2	7.69
UTAH	0	0	0	3.67
VERMONT	0	0	0	6.40
VIRGINIA	64.0	133.5	21.3	5.90
WASHINGTON	0	0	0	2.85
WEST-VIRGINIA	0	127.5	0	6.5
WISCONSIN	0	100.0	0	4.40
WYOMING	0	0	0	3.95

	PCORN77	PSOR77	PWHE77	POAT77	PBAR77
ALABAMA	2.10	1.88	2.05	1.35 0	
ARIZONA	2.20	2.13	2.60	0	2.20
ARKANSAS	2.10	1.62	2.05	1.10	0
CALIFORNIA	2.40	2.35	2.72	1.45	2.20
COLORADO	1.95	1.62	2.11	0.95	2.20
CONNECTICUT	0	0	0	0	0
DELAWARE	2.00	0	2.10	0	1.90
FLORIDA	1.60	0	0	0	0
GEORGIA	1.90	2.04	2.25	1.45	1.65
IDAHO	2.25	0	2.55	1.30	1.90
ILLINOIS	2.15	1.62	2.10	1.10	1.60
INDIANA	2.00	1.62	2.20	1.60	1.45
IOWA	2.00	1.65	2.10	1.10	0
KANSAS	1.95	1.62	2.15	1.10	1.50
KENTUCKY	2.30	1.65	2.00	1.75	1.50
LOUISIANA	2.00	1.68	2.10	1.45	0
MAINE	0	0	0	0.85	0
MARYLAND	2.00	0	2.10	1.50	1.90
MASSACHUSETTS	0	0	0	0	0
MICHIGAN	1.95	0	2.00	1.35	2.55
MINNESOTA	1.90	0	2.50	1.05	1.60
MISSISSIPPI	2.00	1.65	2.00	1.35	0
MISSOURI	2.00	1.48	2.10	1.20	1.55
MONTANA	2.30	0	2.38	1.30	1.70
NEBRASKA	1.95	1.65	2.20	0.95	1.60
NEVADA	0	0	2.63	1.30	1.95
NEW-HAMPSHIRE	0	0	0	0	0
NEW-JERSEY	2.05	0	2.15	1.40	1.75
NEW-MEXICO	2.00	1.88	2.10	0	1.65
NEW-YORK	2.20	0	1.95	1.65	1.50
NORTH-CAROLINA	2.20	1.82	2.20	1.55	1.80
NORTH-DAKOTA	1.90	0	2.44	0.95	1.60
OHIO	1.95	0	2.15	1.50	2.00
OKLAHOMA	2.15	1.79	2.30	1.45	1.60
OREGON	2.45	0	2.65	1.15	1.90
PENNSYLVANIA	2.35	0	2.40	1.60	2.10
RHODE-ISLAND	0	0	0	0	0
SOUTH-CAROLINA	1.95	1.85	2.15	1.40	1.70
SOUTH-DAKOTA	1.85	1.46	2.51	1.10	1.70
TENNESSEE	2.10	1.68	2.25	1.70	1.70
TEXAS	2.20	1.90	2.25	1.30	1.65
UTAH	2.45	0	2.44	1.40	1.85
VERMONT	0	0	0	0	0
VIRGINIA	2.10	1.65	2.15	1.45	1.85
WASHINGTON	2.35	0	2.65	1.30	1.85
WEST-VIRGINIA	2.05	0	2.20	1.30	1.70
WISCONSIN	2.00	0	1.97	1.10	1.55
WYOMING	2.05	0	2.11	1.25	2.15

	PRIC77	PSUN77	PSOY77	PTUR77	PEGG77
ALABAMA	0	0	5.75	0	60.6
ARIZONA	0	0	0	0	48.3
ARKANSAS	9.43	0	6.30	34.5	57.0
CALIFORNIA	9.43	0	0	35.3	50.8
COLORADO	0	0	0	41.0	53.0
CONNECTICUT	0	0	0	59.0	72.3
DELAWARE	0	0	5.40	0	68.3
FLORIDA	0	0	6.00	0	45.9
GEORGIA	0	0	5.95	35.6	63.0
IDAHO	0	0	0	0	50.0
ILLINOIS	0	0	5.90	38.4	56.5
INDIANA	0	0	5.50	34.8	54.8
IOWA	0	0	5.80	32.9	42.2
KANSAS	0	0	5.35	34.0	44.1
KENTUCKY	0	0	6.20	0	50.6
LOUISIANA	9.43	0	5.80	34.5	65.7
MAINE	0	0	0	56.0	66.0
MARYLAND	0	0	5.50	39.2	68.1
MASSACHUSETTS	0	0	0	58.0	69.9
MICHIGAN	0	0	5.60	34.9	49.6
MINNESOTA	0	11.50	5.60	33.4	44.4
MISSISSIPPI	9.43	0	6.35	0	66.4
MISSOURI	9.43	0	5.65	32.7	50.1
MONTANA	0	0	0	0	57.0
NEBRASKA	0	0	5.50	36.4	41.5
NEVADA	0	0	0	0	52.1
NEW-HAMPSHIRE	0	0	0	60.0	69.5
NEW-JERSEY	0	0	5.55	57.0	60.6
NEW-MEXICO	0	0	0	0	59.0
NEW-YORK	0	0	5.10	42.0	53.4
NORTH-CAROLINA	0	0	5.95	37.9	66.3
NORTH-DAKOTA	0	10.40	5.40	35.0	37.0
OHIO	0	0	5.65	41.2	48.8
OKLAHOMA	0	0	5.25	33.0	62.0
OREGON	0	0	0	35.8	54.5
PENNSYLVANIA	0	0	5.50	40.2	53.7
RHODE-ISLAND	0	0	0	58.0	70.1
SOUTH-CAROLINA	0	0	5.90	34.2	56.7
SOUTH-DAKOTA	0	10.30	5.40	34.4	39.4
TENNESSEE	0	0	5.85	34.5	57.8
TEXAS	9.43	10.40	5.35	34.8	62.3
UTAH	0	0	0	37.1	48.2
VERMONT	0	0	0	57.0	75.1
VIRGINIA	0	0	5.80	35.7	65.3
WASHINGTON	0	0	0	0	50.6
WEST-VIRGINIA	0	0	0	33.5	62.5
WISCONSIN	0	0	5.35	37.5	53.1
WYOMING	0	0	0	0	54.0

	PBRO77	PAP77	PGR77	PPCH77	PSU77
ALABAMA	22.0	0	0	14.9	0
ARIZONA	0	0	955.00	0	24.40
ARKANSAS	23.3	8.8	156.00	11.3	0
CALIFORNIA	26.7	7.8	190.00	8.8	26.40
COLORADO	0	9.3	0	13.7	26.30
CONNECTICUT	23.1	13.5	0	24.0	0
DELAWARE	23.0	10.4	0	12.5	0
FLORIDA	22.4	0	0	0	0
GEORGIA	23.7	9.2	0	15.3	0
IDAHO	0	14.9	0	12.0	25.50
ILLINOIS	0	9.9	0	16.4	0
INDIANA	23.4	10.6	0	23.0	0
IOWA	30.5	12.5	0	0	0
KANSAS	0	8.8	0	15.0	21.90
KENTUCKY	22.0	10.7	0	14.6	0
LOUISIANA	23.8	0	0	20.0	0
MAINE	23.1	11.9	0	0	0
MARYLAND	23.0	12.2	0	13.5	0
MASSACHUSETTS	0	12.8	0	22.0	0
MICHIGAN	26.0	7.9	197.00	15.6	20.10
MINNESOTA	27.1	16.4	0	0	20.60
MISSISSIPPI	24.3	0	0	17.0	0
MISSOURI	22.7	12.0	213.00	20.00	0
MONTANA	0	0	0	0	29.10
NEBRASKA	35.0	0	0	0	27.0
NEVADA	0	0	0	0	0
NEW-HAMPSHIRE	0	12.6	0	0	0
NEW-JERSEY	0	9.6	233.00	17.0	0
NEW-MEXICO	0	11.7	0	0	25.00
NEW-YORK	0	8.6	220.00	17.5	0
NORTH-CAROLINA	23.4	8.7	320.00	12.4	0
NORTH-DAKOTA	0	0	0	0	21.40
OHIO	23.1	15.5	202.00	23.5	20.20
OKLAHOMA	23.5	0	0	11.5	0
OREGON	28.5	9.2	0	14.7	23.00
PENNSYLVANIA	25.2	9.1	231.00	12.9	0
RHODE-ISLAND	0	13.1	0	0	0
SOUTH-CAROLINA	22.3	8.8	0	14.2	0
SOUTH-DAKOTA	0	0	0	0	0
TENNESSEE	22.0	10.6	0	13.0	0
TEXAS	25.3	0	0	14.0	23.40
UTAH	0	10.6	0	12.6	26.70
VERMONT	0	12.5	0	0	0
VIRGINIA	22.8	8.4	0	12.0	0
WASHINGTON	29.2	12.8	175.00	10.9	26.50
WEST-VIRGINIA	27.0	9.8	0	14.5	0
WISCONSIN	24.6	12.5	0	0	0
WYOMING	0	0	0	0	28.80

	PCAN77	PCHI77	PCOT77	PTOB77	PPEA77
ALABAMA	0	12.2	47.1	0	22.2
ARIZONA	0	8.4	58.3	0	0
ARKANSAS	0	12.8	52.4	0	0
CALIFORNIA	0	8.1	54.7	0	0
COLORADO	0	10.0	0	0	0
CONNECTICUT	0	11.3	0	0	0
DELAWARE	0	14.0	0	0	0
FLORIDA	19.60	9.5	48.0	120.0	20.7
GEORGIA	0	13.5	49.8	115.1	20.9
IDAHO	0	8.5	0	0	0
ILLINOIS	0	9.0	0	0	0
INDIANA	0	9.5	0	119.5	0
IOWA	0	9.2	0	0	0
KANSAS	0	10.6	0	0	0
KENTUCKY	0	12.0	48.0	121.8	0
LOUISIANA	17.70	11.8	50.6	0	0
MAINE	0	11.3	0	0	0
MARYLAND	0	13.6	0	115.3	0
MASSACHUSETTS	0	11.3	0	0	0
MICHIGAN	0	10.0	0	0	0
MINNESOTA	0	3.7	0	0	0
MISSISSIPPI	0	15.2	52.0	0	22.0
MISSOURI	0	15.0	53.0	109.0	0
MONTANA	0	8.0	0	0	0
NEBRASKA	0	6.8	0	0	0
NEVADA	0	8.2	57.0	0	0
NEW-HAMPSHIRE	0	11.3	0	0	0
NEW-JERSEY	0	11.6	0	0	0
NEW-MEXICO	0	8.5	55.6	0	25.0
NEW-YORK	0	8.6	0	0	0
NORTH-CAROLINA	0	17.0	50.5	113.2	20.6
NORTH-DAKOTA	0	4.0	0	0	0
OHIO	0	9.8	0	121.0	21.4
OKLAHOMA	0	13.0	46.1	0	21.0
OREGON	0	8.5	0	0	0
PENNSYLVANIA	0	19.9	0	0	0
RHODE-ISLAND	0	11.3	0	0	0
SOUTH-CAROLINA	0	12.2	53.1	123.3	21.0
SOUTH-DAKOTA	0	5.0	0	0	0
TENNESSEE	0	16.8	48.0	115.9	0
TEXAS	15.30	13.1	49.1	0	19.6
UTAH	0	7.5	0	0	0
VERMONT	0	11.3	0	0	0
VIRGINIA	0	13.1	43.0	117.5	21.3
WASHINGTON	0	7.5	0	0	0
WEST-VIRGINIA	0	12.5	0	113.0	0
WISCONSIN	0	14.1	0	0	0
WYOMING	0	10.0	0	0	0

	CAT77	VCAT77	HOG77	VHOG77
ALABAMA	733395	223171	225347	86308
ARIZONA	540755	204235	39544	16608
ARKANSAS	745290	240098	122229	46203
CALIFORNIA	1693920	608994	39685	16271
COLORADO	1637960	638260	94628	36621
CONNECTICUT	21130	5929	3153	1167
DELAWARE	8445	2591	20142	7835
FLORIDA	625610	192611	77871	29513
GEORGIA	471820	139345	472888	177806
IDAHO	631650	232485	17299	6574
ILLINOIS	1043055	381722	2376504	931590
INDIANA	711460	251654	1395713	566659
IOWA	2885950	1073679	5112676	2024620
KANSAS	2790210	975315	757605	303042
KENTUCKY	899890	290257	358752	140272
LOUISIANA	467730	142372	43240	15826
MAINE	24330	6684	3013	1115
MARYLAND	93980	29755	50871	19789
MASSACHUSETTS	19200	5363	15832	5858
MICHIGAN	513715	168197	233769	94676
MINNESOTA	1368370	434334	1392757	544568
MISSISSIPPI	648130	205336	107896	42727
MISSOURI	1945345	655021	1320098	524079
MONTANA	840080	299480	67741	25403
NEBRASKA	2732940	1018645	1102213	434272
NEVADA	162835	58353	3162	1300
NEW-HAMPSHIRE	15470	4238	2628	972
NEW-JERSEY	31070	8942	16434	6278
NEW-MEXICO	589640	225695	20985	8499
NEW-YORK	290900	84313	41210	15660
NORTH-CAROLINA	260490	73538	621943	243180
NORTH-DAKOTA	813920	286194	96336	36704
OHIO	650975	226128	618789	245659
OKLAHOMA	1998835	670296	105885	41719
OREGON	477815	158749	350050	13354
PENNSYLVANIA	419295	139623	201835	78917
RHODE-ISLAND	1764	500	2572	952
SOUTH-CAROLINA	162850	47981	152573	58130
SOUTH-DAKOTA	1615220	609556	579780	230752
TENNESSEE	829170	237487	350392	136302
TEXAS	5685280	1887864	301964	114746
UTAH	246220	82362	18249	7044
VERMONT	71080	19174	3234	1197
VIRGINIA	420540	122647	148301	57392
WASHINGTON	399525	138045	23183	8879
WEST-VIRGINIA	122425	35217	25922	9980
WISCONSIN	919740	277129	528429	205559
WYOMING	520810	188359	8923	3418

	SHE77	VSHE77	MILK77	VMILK77
ALABAMA	0	0	656	75719
ARIZONA	18515	7700	905	95147
ARKANSAS	0	0	703	74888
CALIFORNIA	61639	28565	11871	1190020
COLORADO	67029	34609	805	91222
CONNECTICUT	231	133	612	68016
DELAWARE	0	0	134	14330
FLORIDA	0	0	1945	241449
GEORGIA	0	0	1263	135870
IDAHO	43576	20178	1551	145120
ILLINOIS	11311	4250	2442	234608
INDIANA	9270	3370	2232	226546
IOWA	26296	13258	4111	384144
KANSAS	11821	5570	1419	140402
KENTUCKY	2136	862	2320	235503
LOUISIANA	490	175	1062	117502
MAINE	562	259	625	69351
MARYLAND	1033	417	1553	164952
MASSACHUSETTS	343	208	589	67740
MICHIGAN	7550	3488	4670	461341
MINNESOTA	18851	8622	9278	835452
MISSISSIPPI	0	0	836	88031
MISSOURI	7663	3465	2899	276869
MONTANA	22163	8834	276	28792
NEBRASKA	11924	5479	1293	122438
NEVADA	6727	3259	193	19404
NEW-HAMPSHIRE	311	178	332	36849
NEW-JERSEY	348	139	542	57585
NEW-MEXICO	14554	7739	415	48266
NEW-YORK	3192	1422	10012	1004390
NORTH-CAROLINA	505	140	1590	182212
NORTH-DAKOTA	12693	5779	898	79703
OHIO	24837	10591	4447	447523
OKLAHOMA	4560	2009	1083	113232
OREGON	23312	10752	1020	106883
PENNSYLVANIA	3939	1963	7666	821950
RHODE-ISLAND	67	36	55	6321
SOUTH-CAROLINA	0	0	509	61490
SOUTH-DAKOTA	57849	27152	1624	145958
TENNESSEE	604	252	1917	198058
TEXAS	117170	49849	3305	363757
UTAH	28002	17168	915	89575
VERMONT	398	202	2063	217860
VIRGINIA	10362	4643	1867	198336
WASHINGTON	2155	1414	2524	256267
WEST-VIRGINIA	7805	3195	307	33933
WISCONSIN	6500	2946	20515	1937876
WYOMING	49285	19428	114	12078

	VEG77	VVEG77
ALABAMA	93900	21781
ARIZONA	573400	104328
ARKANSAS	52450	9692
CALIFORNIA	12198100	1515010
COLORADO	240000	28811
CONNECTICUT	13850	1939
DELAWARE	63400	9131
FLORIDA	1873700	444844
GEORGIA	163200	16608
IDAHO	282150	22672
ILLINOIS	369750	34639
INDIANA	287600	26230
IOWA	61150	3366
KANSAS	0	0
KENTUCKY	24900	3888
LOUISIANA	7250	2150
MAINE	9000	1411
MARYLAND	185800	20858
MASSACHUSETTS	48250	8374
MICHIGAN	603600	102390
MINNESOTA	808850	57218
MISSISSIPPI	48850	2925
MISSOURI	29250	1840
MONTANA	0	0
NEBRASKA	1000	133
NEVADA	0	0
NEW-HAMPSHIRE	0	0
NEW-JERSEY	372800	66654
NEW-MEXICO	98300	14893
NEW-YORK	929900	125178
NORTH-CAROLINA	217650	34365
NORTH-DAKOTA	0	0
OHIO	636400	59840
OKLAHOMA	50950	3062
OREGON	793150	75111
PENNSYLVANIA	221100	22090
RHODE-ISLAND	0	0
SOUTH-CAROLINA	160550	22976
SOUTH-DAKOTA	400	54
TENNESSEE	60150	16005
TEXAS	1255550	245237
UTAH	40300	3489
VERMONT	0	0
VIRGINIA	107650	17994
WASHINGTON	586650	82587
WEST-VIRGINIA	1200	110
WISCONSIN	1308200	108096
WYOMING	0	0

	PGAS	PDIESEL	PMOTOR	PFUEL	PLPG
ALABAMA	.560	.450	3.00	.450	.440
ARIZONA	.600	.450	3.85	.490	.510
ARKANSAS	.560	.430	2.55	.450	.400
CALIFORNIA	.580	.460	2.50	.480	.480
COLORADO	.580	.440	2.40	.480	.370
CONNECTICUT	.610	.520	3.30	.500	.570
DELAWARE	.600	.500	2.95	.500	.530
FLORIDA	.590	.520	3.40	.530	.480
GEORGIA	.590	.500	3.55	.460	.450
IDAHO	.600	.440	2.20	.450	.440
ILLINOIS	.600	.490	3.10	.490	.440
INDIANA	.590	.460	3.35	.480	.440
IOWA	.580	.460	2.55	.470	.410
KANSAS	.590	.450	2.30	.470	.350
KENTUCKY	.590	.460	2.90	.500	.470
LOUISIANA	.560	.420	3.35	.420	.430
MAINE	.610	.520	3.30	.500	.570
MARYLAND	.600	.500	2.95	.500	.530
MASSACHUSETTS	.610	.520	3.30	.500	.570
MICHIGAN	.550	.480	2.70	.490	.440
MINNESOTA	.590	.450	2.20	.470	.420
MISSISSIPPI	.570	.530	3.50	.620	.420
MISSOURI	.570	.450	2.45	.450	.400
MONTANA	.590	.450	2.20	.460	.390
NEBRASKA	.600	.450	2.20	.450	.360
NEVADA	.590	.480	3.60	.490	.500
NEW-HAMPSHIRE	.610	.520	3.30	.500	.57
NEW-JERSEY	.580	.510	4.00	.510	.450
NEW-MEXICO	.570	.450	2.65	.490	.370
NEW-YORK	.610	.500	2.75	.520	.570
NORTH-CAROLINA	.570	.530	2.50	.500	.430
NORTH-DAKOTA	.600	.460	2.20	.460	.380
OHIO	.590	.480	2.40	.470	.420
OKLAHOMA	.560	.460	2.95	.480	.400
OREGON	.570	.440	2.35	.450	.550
PENNSYLVANIA	.580	.490	2.35	.480	.490
RHODE-ISLAND	.610	.520	3.30	.500	.570
SOUTH-CAROLINA	.580	.510	2.95	.480	.450
SOUTH-DAKOTA	.590	.480	2.20	.480	.410
TENNESSEE	.570	.470	3.05	.510	.480
TEXAS	.530	.430	2.60	.490	.370
UTAH	.580	.440	2.95	.440	.420
VERMONT	.610	.520	3.30	.500	.570
VIRGINIA	.570	.480	2.35	.490	.450
WASHINGTON	.610	.440	2.40	.480	.490
WEST-VIRGINIA	.590	.600	3.35	.580	.450
WISCONSIN	.580	.470	2.20	.470	.440
WYOMING	.600	.460	3.00	.480	.420

	CHI77	BRO77	EGG77	TURK77
ALABAMA	64225	1583966	3183	0
ARIZONA	941	0	140	0
ARKANSAS	124142	2050409	3182	197979
CALIFORNIA	73722	495000	8345	344880
COLORADO	6159	0	508	92400
CONNECTICUT	13696	4549	863	677
DELAWARE	3040	624324	128	0
FLORIDA	47881	295335	2998	0
GEORGIA	90746	1797752	5535	30374
IDAHO	4978	0	192	0
ILLINOIS	17002	0	1389	13355
INDIANA	47482	50409	3004	77860
IOWA	23817	31446	2004	126189
KANSAS	10995	0	530	2938
KENTUCKY	11079	12600	556	0
LOUISIANA	16040	235446	598	19
MAINE	37609	365140	1849	79
MARYLAND	7561	794036	308	1647
MASSACHUSETTS	10222	0	354	2600
MICHIGAN	20851	3745	1530	29040
MINNESOTA	32869	61060	2120	375194
MISSISSIPPI	43239	972215	1775	0
MISSOURI	34992	93811	1168	181166
MONTANA	3174	0	175	0
NEBRASKA	8388	6720	739	9656
NEVADA	30	0	3.1	0
NEW-HAMPSHIRE	6696	0	210	505
NEW-JERSEY	5107	0	446	1183
NEW-MEXICO	5370	0	288	2884
NEW-YORK	32192	0	1825	0
NORTH-CAROLINA	97428	1357084	2968	290400
NORTH-DAKOTA	2372	0	99	12479
OHIO	38166	71780	1934	49080
OKLAHOMA	8759	105458	487	20280
OREGON	6229	62400	525	24030
PENNSYLVANIA	78286	352560	2943	67773
RHODE-ISLAND	919	0	50.7	210
SOUTH-CAROLINA	14282	120684	1248	55912
SOUTH-DAKOTA	10396	0	579	23352
TENNESSEE	15156	180871	993	57
TEXAS	45374	72756	2380	163400
UTAH	2828	0	335	61805
VERMONT	1701	0	121	154
VIRGINIA	2187	372491	819	140843
WASHINGTON	18716	67384	1050	0
WEST-VIRGINIA	3138	50394	192	33453
WISCONSIN	18044	43628	993	107554
WYOMING	126	0	23.7	0

	RAIN	COWS	SOWS	EWES
ALABAMA	-1.11	905897	117027	1190
ARIZONA	-0.40	325105	31695	85818
ARKANSAS	-1.23	947521	81834	3308
CALIFORNIA	-0.05	1701189	31181	752287
COLORADO	-0.79	912360	59431	396178
CONNECTICUT	0.12	57426	1418	2752
DELAWARE	0.75	15055	10726	370
FLORIDA	1.35	1318548	64447	2644
GEORGIA	-1.26	859695	254232	2632
IDAHO	0.41	749306	15728	335842
ILLINOIS	0.95	917465	905457	99057
INDIANA	1.19	611572	583580	70840
IOWA	2.14	1962979	2110441	241698
KANSAS	-0.89	1706253	287079	129669
KENTUCKY	0.76	1271412	186926	18244
LOUISIANA	-0.99	674052	19434	7852
MAINE	-0.89	69417	1889	7813
MARYLAND	0.91	176275	30515	11438
MASSACHUSETTS	-0.54	59735	7416	4710
MICHIGAN	-0.19	530983	162815	66761
MINNESOTA	1.78	1262498	620274	151196
MISSISSIPPI	-1.46	938928	490052	3558
MISSOURI	1.48	2353336	639221	77572
MONTANA	1.13	1515583	31305	341587
NEBRASKA	1.51	2113783	530869	110121
NEVADA	-0.24	295950	1978	98846
NEW-HAMPSHIRE	-1.53	36088	1718	3928
NEW-JERSEY	0.21	55883	6659	5900
NEW-MEXICO	-1.09	587393	10522	263488
NEW-YORK	-0.91	942186	20514	33652
NORTH-CAROLINA	-0.74	479407	286381	4948
NORTH-DAKOTA	0.23	997930	56183	120666
OHIO	-0.54	714342	294904	206321
OKLAHOMA	-1.58	2018338	58143	60245
OREGON	0.30	744101	17938	286407
PENNSYLVANIA	-0.21	839335	94556	67575
RHODE-ISLAND	0.34	6110	1334	760
SOUTH-CAROLINA	-0.64	278044	78974	559
SOUTH-DAKOTA	1.44	1654291	289226	454863
TENNESSEE	-0.39	1131926	186591	7792
TEXAS	-1.02	5692335	130116	1652623
UTAH	-0.56	389314	6901	440349
VERMONT	-0.62	197727	2046	6111
VIRGINIA	0.11	733156	78407	93631
WASHINGTON	0.49	545301	13973	49286
WEST-VIRGINIA	1.97	241041	7667	76736
WISCONSIN	3.03	1949819	251374	52928
WYOMING	0.17	695047	4542	720772

	PHAY77
ALABAMA	55.50
ARIZONA	64.50
ARKANSAS	44.00
CALIFORNIA	59.00
COLORADO	56.50
CONNECTICUT	69.00
DELAWARE	83.00
FLORIDA	63.00
GEORGIA	60.50
IDAHO	46.00
ILLINOIS	53.00
INDIANA	54.50
IOWA	47.50
KANSAS	43.00
KENTUCKY	47.50
LOUISIANA	47.00
MAINE	54.00
MARYLAND	80.50
MASSACHUSETTS	69.00
MICHIGAN	58.00
MINNESOTA	48.00
MISSISSIPPI	46.00
MISSOURI	49.50
MONTANA	56.00
NEBRASKA	33.00
NEVADA	55.50
NEW-HAMPSHIRE	64.00
NEW-JERSEY	74.00
NEW-MEXICO	57.50
NEW-YORK	67.50
NORTH-CAROLINA	73.00
NORTH-DAKOTA	43.50
OHIO	56.50
OKLAHOMA	53.50
OREGON	58.50
PENNSYLVANIA	75.00
RHODE-ISLAND	69.00
SOUTH-CAROLINA	61.50
SOUTH-DAKOTA	36.00
TENNESSEE	46.00
TEXAS	49.50
UTAH	58.00
VERMONT	64.00
VIRGINIA	77.00
WASHINGTON	54.50
WEST-VIRGINIA	51.00
WISCONSIN	54.50
WYOMING	45.00

	GAS	DIESEL	LPG	FUEL	MOTOR
ALABAMA	27730	21777	10443	626	5143
ARIZONA	13095	12080	2604	347	2755
ARKANSAS	42645	46293	17965	1268	9216
CALIFORNIA	106649	85867	16738	2647	17571
COLORADO	39095	23170	6123	785	5136
CONNECTICUT	4069	1230	1270	2394	657
DELAWARE	3712	2234	1216	380	557
FLORIDA	35981	31273	6910	1976	5776
GEORGIA	39653	39094	17230	1110	7037
IDAHO	36584	23517	1744	884	4797
ILLINOIS	131062	92772	35097	4205	16627
INDIANA	70052	48341	26127	4523	10083
IOWA	129462	91642	48786	3759	19271
KANSAS	87023	70289	14820	1549	13992
KENTUCKY	44537	23608	3913	1623	8160
LOUISIANA	27113	35856	5773	1175	6366
MAINE	6821	2884	329	2925	1158
MARYLAND	14244	7874	2242	2392	2241
MASSACHUSETTS	4789	1108	516	4447	924
MICHIGAN	48196	29217	7403	3753	6941
MINNESOTA	103202	66807	28639	5415	14031
MISSISSIPPI	32866	39963	10625	673	7748
MISSOURI	90742	44036	13027	1546	11699
MONTANA	41283	24899	3526	2052	5101
NEBRASKA	86415	83104	24787	2821	14362
NEVADA	4975	2679	650	238	635
NEW-HAMPSHIRE	1833	545	174	970	313
NEW-JERSEY	9405	3374	1174	4192	1235
NEW-MEXICO	14731	7277	4607	313	2366
NEW-YORK	43389	19919	3926	10013	6664
NORTH-CAROLINA	55399	35737	39794	15114	16124
NORTH-DAKOTA	67102	56240	5304	2845	8785
OHIO	62797	41379	14194	5061	9314
OKLAHOMA	48910	36643	14595	1012	8632
OREGON	28792	15090	1531	1801	3834
PENNSYLVANIA	44305	18334	5517	12163	6380
RHODE-ISLAND	706	251	33	395	114
SOUTH-CAROLINA	20264	18037	5475	3531	4437
SOUTH-DAKOTA	61251	39695	7511	2287	7517
TENNESSEE	33264	24692	1961	1256	6359
TEXAS	140594	117906	36589	4412	26686
UTAH	12860	6022	923	339	1564
VERMONT	5323	2647	247	706	841
VIRGINIA	28776	14219	7961	4600	6656
WASHINGTON	38194	24181	1799	2154	5261
WEST-VIRGINIA	6503	1987	603	322	988
WISCONSIN	79112	33496	12469	4041	10501
WYOMING	14725	6127	2314	191	1601

	FARMS	VLAND	HCLAND	PLAND	ILAND
ALABAMA	57469	7330861	3419676	4636257	58479
ARIZONA	7568	5535286	1083927	15981386	1171515
ARKANSAS	58739	11874267	7622992	5465581	1682861
CALIFORNIA	81594	39033984	8879239	21083208	8574214
COLORADO	29554	11311553	5873014	23377413	3435628
CONNECTICUT	4553	1105098	177824	125994	6950
DELAWARE	3629	978624	500026	35062	33677
FLORIDA	44017	15407946	2755336	8355983	1970286
GEORGIA	58602	10551787	4737110	3820349	462897
IDAHO	26355	8481761	4871515	6882727	3496442
ILLINOIS	109892	55459898	22810588	3343585	130116
INDIANA	88382	27112828	11896243	2250785	75251
IOWA	126380	52334351	23782829	5883403	100777
KANSAS	77091	24122664	19084010	18916690	2684521
KENTUCKY	109946	13033928	4600416	6416213	14388
LOUISIANA	38876	9541077	4900562	2877705	681208
MAINE	8149	875996	487234	219227	6975
MARYLAND	18714	4923716	1509179	464566	28533
MASSACHUSETTS	5871	967514	210973	145345	16893
MICHIGAN	68211	11115789	6947059	1420947	226133
MINNESOTA	102945	26033501	19189946	4121931	271856
MISSISSIPPI	54155	9359303	5954225	4792337	307751
MISSOURI	121910	22553369	12651085	13536799	341805
MONTANA	24356	11790844	8784780	40694741	2070673
NEBRASKA	65872	24458789	16421128	24472537	5687542
NEVADA	2846	1736398	586266	8329708	882062
NEW-HAMPSHIRE	3276	486784	135091	106098	1788
NEW-JERSEY	9871	2781572	611583	146850	77589
NEW-MEXICO	14184	5919491	1187335	37820901	863885
NEW-YORK	49232	6650387	4473729	2522777	56079
NORTH-CAROLINA	89315	12018845	4552817	2241670	92279
NORTH-DAKOTA	41137	14557012	19097318	11448802	140567
OHIO	95879	23841559	10272707	2758938	26292
OKLAHOMA	79341	17638443	8691115	22536986	600418
OREGON	34581	9155043	3275188	12391173	1898948
PENNSYLVANIA	59877	11130315	4327875	1960170	14871
RHODE-ISLAND	863	173512	24886	13966	2985
SOUTH-CAROLINA	33412	4841383	2565706	1457712	32446
SOUTH-DAKOTA	39555	10969524	13917084	21486641	336921
TENNESSEE	96996	11266889	4468096	5312809	14082
TEXAS	194141	53275147	20726861	105760492	7008763
UTAH	13696	3954770	1157643	7186189	1158911
VERMONT	7258	1165074	579014	537725	1586
VIRGINIA	56830	9274771	2703812	3965884	43820
WASHINGTON	37688	11299483	5068503	6076135	1679198
WEST-VIRGINIA	20506	2299014	600707	2008240	1234
WISCONSIN	89913	15407398	9955021	3915966	234207
WYOMING	8444	4660415	1800571	27325378	1674442

	FEDPRO	PASTOR	OP1	OP2	OP3	OP4	OP5	OVER
ALABAMA	61932	1794557	1138	6597	11470	14141	13857	10266
ARIZONA	21366	137052	127	1122	1764	1981	1637	937
ARKANSAS	59163	2445719	1222	7407	12072	14490	13823	9725
CALIFORNIA	85586	1624167	1362	8843	16880	21139	20816	12554
COLORADO	547364	1071321	952	4138	6038	6959	7024	4443
CONNECTICUT	790	54856	64	471	922	1197	1108	791
DELAWARE	5441	18638	122	474	724	870	869	570
FLORIDA	33669	1292488	777	5246	8629	11234	10408	7723
GEORGIA	168029	1543182	1210	6680	11758	13736	14242	10976
IDAHO	288418	763104	750	3670	5539	6274	6460	3662
ILLINOIS	564641	1514955	4808	15666	21230	25794	27024	15370
INDIANA	318318	1099668	3484	12714	18620	20930	20066	12568
IOWA	1076018	3170580	7104	20919	24738	30951	29578	13090
KANSAS	2169076	3146869	3478	10100	12804	17443	18755	14511
KENTUCKY	72677	4131833	3832	15215	22239	24225	23812	20623
LOUISIANA	24567	1168410	1126	4757	7666	8681	9496	7150
MAINE	2792	97735	121	1273	1793	2105	1718	1139
MARYLAND	33792	245418	564	2010	3602	4633	4519	3386
MASSACHUSETTS	1077	76915	90	589	1187	1343	1531	1131
MICHIGAN	245452	757696	2316	9136	14303	16734	15640	10082
MINNESOTA	898607	1646788	4685	16272	22123	24663	23819	11383
MISSISSIPPI	91426	1955217	1147	5937	10316	13047	12591	11117
MISSOURI	435604	6933892	3895	15762	24020	28015	27939	22279
MONTANA	795470	1184625	615	3508	4541	6057	6237	3398
NEBRASKA	1327414	2360201	3591	10204	11280	15837	15946	9014
NEVADA	6310	178305	30	299	610	815	702	390
NEW-HAMPSHIRE	593	45785	44	398	840	708	706	580
NEW-JERSEY	6531	81732	164	961	2071	2467	2426	1782
NEW-MEXICO	147891	470859	275	1555	2906	3349	3274	2825
NEW-YORK	101402	1193456	929	6141	11008	12439	11419	7296
NORTH-CAROLINA	93195	984459	2617	10638	15589	21724	22478	16269
NORTH-DAKOTA	1855286	1603300	2234	6838	7218	10092	10160	4595
OHIO	152590	1262587	3795	13223	20026	22561	21930	14344
OKLAHOMA	985467	4197012	2739	9168	15102	19501	17797	15034
OREGON	93674	808035	609	4875	7504	8320	7776	5497
PENNSYLVANIA	56403	1033733	1398	7787	12488	15240	13879	9085
RHODE-ISLAND	249	7873	9	72	162	247	217	156
SOUTH-CAROLINA	59586	623460	682	3844	5745	7965	8008	7168
SOUTH-DAKOTA	986033	2305070	2091	6150	6673	9689	9966	4986
TENNESSEE	44510	2981283	2515	11487	18632	21118	23100	20144
TEXAS	1493745	12117105	5107	19311	33323	47270	48781	40349
UTAH	49876	479934	266	1393	2731	3609	3192	2505
VERMONT	1889	253140	159	1159	1756	1780	1394	1010
VIRGINIA	60001	1719007	1159	6438	10024	12928	13925	12356
WASHINGTON	298741	14429	555	5096	8658	9938	8386	5055
WEST-VIRGINIA	4528	812519	271	2064	3952	4591	4773	4855
WISCONSIN	314410	1477528	2446	13673	19010	22581	21011	11192
WYOMING	62578	470819	222	1037	1621	2232	2059	1273

	DAY0	DAY1	DAY2	DAY3	MVPROS
ALABAMA	18509	4676	4499	27584	1571196
ARIZONA	2810	588	572	3384	1287593
ARKANSAS	23318	5010	5114	23048	2511402
CALIFORNIA	30891	7447	7865	32730	9307101
COLORADO	12366	3755	2659	9439	2593878
CONNECTICUT	1753	325	438	1879	228460
DELAWARE	1574	340	321	1221	325741
FLORIDA	15751	3114	3420	20178	3041400
GEORGIA	22940	4430	4175	24094	2388886
IDAHO	10870	3543	2374	8413	1640151
ILLINOIS	49502	14891	7666	32529	5931367
INDIANA	31618	8371	6526	38084	3375034
IOWA	64111	19742	6972	28165	8203743
KANSAS	34969	10461	5973	22028	5008426
KENTUCKY	39727	11790	8752	43783	1850886
LOUISIANA	14871	3568	3768	15024	1225117
MAINE	3116	932	851	2976	398676
MARYLAND	7348	1683	1597	7316	804903
MASSACHUSETTS	2373	438	537	2294	213473
MICHIGAN	24093	5523	5396	30950	1938147
MINNESOTA	50134	13207	7914	25454	4539020
MISSISSIPPI	18372	4453	5259	23645	1694939
MISSOURI	47628	12447	10406	45678	3358997
MONTANA	12214	3367	1885	5519	1180900
NEBRASKA	36035	10009	3466	11500	5157756
NEVADA	1116	298	267	1087	199240
NEW-HAMPSHIRE	1061	342	316	1436	87970
NEW-JERSEY	3843	674	953	4054	357190
NEW-MEXICO	5509	1550	1239	5395	785824
NEW-YORK	22309	4411	4092	16738	1883901
NORTH-CAROLINA	36800	9610	6663	30991	3025302
NORTH-DAKOTA	22750	7326	3046	5403	1791198
OHIO	33475	9087	7413	42435	2868701
OKLAHOMA	26924	7060	6995	35327	2364126
OREGON	11505	3373	3230	15397	1282547
PENNSYLVANIA	23235	6015	5188	22741	2181290
RHODE-ISLAND	361	48	68	364	26425
SOUTH-CAROLINA	11611	3534	2779	14147	865739
SOUTH-DAKOTA	22191	6411	2129	6047	1902025
TENNESSEE	32580	8751	7400	43853	1419535
TEXAS	67057	17456	16510	85755	8299496
UTAH	4396	1268	1472	6034	461313
VERMONT	3472	768	672	2095	273488
VIRGINIA	21759	5362	4238	22965	1300596
WASHINGTON	13548	3586	3409	16043	2093206
WEST-VIRGINIA	6600	1639	1663	9921	198411
WISCONSIN	45475	9401	6081	25479	3464336
WYOMING	3972	1071	732	2309	532584

	CORN	SORGH	WHEAT	OATS	BARLEY
ALABAMA	23514435	601482	1459819	1330519	0
ARIZONA	2721308	1536100	7387023	0	2029388
ARKANSAS	1322617	10148283	8778272	2240254	0
CALIFORNIA	33341710	7425357	32854525	4675000	41044906
COLORADO	78453043	10320189	55124192	1864262	12695858
CONNECTICUT	0	0	0	0	0
DELAWARE	15083997	0	576855	0	1109242
FLORIDA	15501845	0	0	0	0
GEORGIA	78327544	1233505	3278871	4633227	0
IDAHO	4944918	0	69391233	2581597	62103837
ILLINOIS	1187626245	4233845	31549720	12945028	0
INDIANA	630584415	975000	22160176	5234789	0
IOWA	1398075929	1584714	986591	49476077	0
KANSAS	154781674	176588382	269917723	3475213	1664487
KENTUCKY	112035068	1426000	5981857	264843	663060
LOUISIANA	1961216	578000	398757	0	0
MAINE	0	0	0	2639237	0
MARYLAND	55605908	0	2606410	934542	3557276
MASSACHUSETTS	0	0	0	0	0
MICHIGAN	188087193	0	15042125	23366826	920822
MINNESOTA	571348845	0	80967999	89752394	46433852
MISSISSIPPI	5279756	720356	1848575	0	0
MISSOURI	189719845	60366904	27586005	1132262	0
MONTANA	1251083	0	134245154	8515349	52329317
NEBRASKA	708825844	127902094	73592940	17042495	1034456
NEVADA	0	0	1059808	0	1748420
NEW-HAMPSHIRE	0	0	0	0	0
NEW-JERSEY	9365573	0	716058	298793	623514
NEW-MEXICO	6220194	9434207	5478678	0	867490
NEW-YORK	51336676	0	2211787	16166545	0
NORTH-CAROLINA	114787976	2766804	4377477	3650860	3091104
NORTH-DAKOTA	20259744	0	270194658	54331933	106208672
OHIO	351512550	0	36515172	18572383	0
OKLAHOMA	3770666	18079445	125656425	2985169	1766788
OREGON	1311192	0	46014259	3552414	11381003
PENNSYLVANIA	115035772	0	6333932	15870985	3902497
RHODE-ISLAND	0	0	0	0	0
SOUTH-CAROLINA	29559714	480000	1766109	3245264	705962
SOUTH-DAKOTA	169315144	16053179	64391136	85849628	21098204
TENNESSEE	42690855	1224000	5071442	321002	0
TEXAS	115369979	205334613	55476615	12393526	1080000
UTAH	1176010	0	6651061	784187	8970032
VERMONT	0	0	0	147097	0
VIRGINIA	52096787	517000	4436278	1027364	5117288
WASHINGTON	7775493	0	123730351	1740000	22757960
WEST-VIRGINIA	5652726	0	179472	334498	157358
WISCONSIN	289738046	0	1609024	61300474	1397148
WYOMING	2741107	0	6629047	2610468	8731640

	SOYBEA	COTTON	TOBACC	PEANUT	HAYCROP
ALABAMA	31613980	287887	0	508936899	1052226
ARIZONA	0	1134238	0	0	965886
ARKANSAS	103653380	647820	0	0	1399211
CALIFORNIA	0	1911617	0	0	6272203
COLORADO	0	0	0	0	3029193
CONNECTICUT	0	0	4829151	0	198322
DELAWARE	7542863	0	0	0	46781
FLORIDA	8019411	3800	21514731	154749074	656264
GEORGIA	27258060	103800	113094972	1547875195	951026
IDAHO	0	0	0	0	4019697
ILLINOIS	302116388	0	0	0	3195916
INDIANA	135455762	0	14187896	0	2071190
IOWA	267764277	0	0	0	6763422
KANSAS	27075304	0	0	0	4486891
KENTUCKY	36090270	0	467381935	0	2790247
LOUISIANA	74854892	472953	0	0	703744
MAINE	0	0	0	0	380891
MARYLAND	11605883	0	30581964	0	599417
MASSACHUSETTS	0	0	1536802	0	258428
MICHIGAN	21354896	0	0	0	3722636
MINNESOTA	123035099	0	0	0	7321250
MISSISSIPPI	74715064	1340624	0	10979733	1004049
MISSOURI	141997694	180518	4762133	0	5871578
MONTANA	0	0	0	0	4378865
NEBRASKA	37698632	0	0	0	6752806
NEVADA	0	1000	0	0	1080470
NEW-HAMPSHIRE	0	0	0	0	181344
NEW-JERSEY	5432996	0	0	0	299304
NEW-MEXICO	0	118159	0	18619438	1000681
NEW-YORK	539339	0	0	0	4969261
NORTH-CAROLINA	35673243	47304	841585627	449760447	684127
NORTH-DAKOTA	4102814	0	0	0	4952900
OHIO	121620309	0	21663484	0	3446974
OKLAHOMA	5155849	338606	0	177326997	2960221
OREGON	0	0	0	0	2595349
PENNSYLVANIA	2344379	0	21942346	0	4441686
RHODE-ISLAND	0	0	0	0	22745
SOUTH-CAROLINA	29280644	114318	146153024	32177953	427131
SOUTH-DAKOTA	11538274	0	0	0	6848553
TENNESSEE	49113426	234921	134354346	0	1875372
TEXAS	15999980	3748515	0	397931643	5385486
UTAH	0	0	0	0	1749997
VERMONT	0	0	0	0	876374
VIRGINIA	13336708	100	140529864	300748445	1597888
WASHINGTON	0	0	0	0	2638818
WEST-VIRGINIA	0	0	2432376	0	762890
WISCONSIN	6609315	0	19626260	0	13052866
WYOMING	0	0	0	0	1917710

	DPSOLD	PPPSOLD	APHA
ALABAMA	66168	652821	0
ARIZONA	92236	7523	0
ARKANSAS	67183	923893	13000000
CALIFORNIA	1128207	703668	480000000
COLORADO	82131	58323	70000000
CONNECTICUT	63278	65201	44397816
DELAWARE	11874	194360	14500000
FLORIDA	225954	223278	0
GEORGIA	141963	853913	22000000
IDAHO	143678	10900	113645988
ILLINOIS	218287	79148	73774837
INDIANA	188370	235409	58021002
IOWA	313119	144365	10000000
KANSAS	117003	26305	15000000
KENTUCKY	202827	24579	15000000
LOUISIANA	109028	122646	0
MAINE	69047	202795	72410244
MARYLAND	148285	280002	88272863
MASSACHUSETTS	61184	18584	91420913
MICHIGAN	434999	78197	772834906
MINNESOTA	767599	303334	28000000
MISSISSIPPI	83687	384836	0
MISSOURI	227605	177263	58000000
MONTANA	26777	8301	0
NEBRASKA	100846	31619	0
NEVADA	16333	105	0
NEW-HAMPSHIRE	36935	18141	57399709
NEW-JERSEY	51621	17779	72949594
NEW-MEXICO	46004	14106	17000000
NEW-YORK	1009894	103349	1023838023
NORTH-CAROLINA	154610	759712	228818484
NORTH-DAKOTA	74907	9219	0
OHIO	391694	147422	114475068
OKLAHOMA	98720	97516	0
OREGON	108523	58472	140944955
PENNSYLVANIA	760022	334456	374933037
RHODE-ISLAND	5391	3222	0
SOUTH-CAROLINA	52073	134013	0
SOUTH-DAKOTA	121239	26366	0
TENNESSEE	185822	100992	8000000
TEXAS	355894	419064	0
UTAH	89443	53874	24031838
VERMONT	218680	6259	50012866
VIRGINIA	193771	214553	480037978
WASHINGTON	259481	73570	2154641278
WEST-VIRGINIA	34531	35196	285354972
WISCONSIN	1871708	116163	67145486
WYOMING	10853	287	0

	RSH67	RSH68	RSH69	RSH70	RSH71
ALABAMA	6567192	5613463	6184101	6649122	6566249
ARIZONA	4950679	4348344	4967799	5105581	5434140
ARKANSAS	4881850	4550635	4793219	5450389	6088737
CALIFORNIA	25747207	28125085	30404147	30672713	32686499
COLORADO	3347777	2862807	3253972	3528604	3913593
CONNECTICUT	2710824	1872716	1941090	4010944	4812075
DELAWARE	1237322	1181476	1267119	1342379	1587176
FLORIDA	6386930	9731020	11732746	13796494	15527690
GEORGIA	11207952	6804273	8162652	9004901	9513360
IDAHO	2814180	2228801	2682691	2769969	3083379
ILLINOIS	7282220	7532586	7903444	8131395	8867037
INDIANA	6774907	6541908	8101673	9684211	9573340
IOWA	10959353	8527854	8714111	9062798	9627895
KANSAS	6031972	6360139	9198728	7970479	6801094
KENTUCKY	5170523	4529725	4948962	5799366	6985281
LOUISIANA	8261293	7211128	7411797	7826053	8800509
MAINE	1733703	1698806	1756852	1972385	2324226
MARYLAND	2972093	3437765	3342227	3712241	3586077
MASSACHUSETTS	1788321	1608327	1993559	2230409	2250622
MICHIGAN	10904169	9553964	9779798	9677362	10318605
MINNESOTA	7595075	5758568	5868141	6772149	7002763
MISSISSIPPI	7613196	4156133	4590531	4797420	4699531
MISSOURI	9243540	7052138	7813241	8212329	7986431
MONTANA	4354748	3219687	3429706	3778006	4068576
NEBRASKA	7907489	6720087	8742375	8704739	9205963
NEVADA	1901644	1389227	1384763	1689940	1666210
NEW-HAMPSHIRE	1108452	969639	1055759	1022083	1143360
NEW-JERSEY	8616980	5195509	5820039	6565621	6606120
NEW-MEXICO	2585824	1916076	1978290	2197548	2428385
NEW-YORK	15561915	13926252	12880277	13874324	15426562
NORTH-CAROLINA	10617780	9334296	9415276	11527211	12350802
NORTH-DAKOTA	5675587	3914872	3274232	3799025	4147952
OHIO	3923362	6117804	6864458	7166444	7695012
OKLAHOMA	4035252	4221440	5271180	4714460	5824244
OREGON	9420322	7630654	7111577	8277717	7352607
PENNSYLVANIA	6036318	6587245	6857477	6920121	7719366
RHODE-ISLAND	1179679	966314	1025016	1205157	1450742
SOUTH-CAROLINA	3791942	2517531	2740931	3174282	4328826
SOUTH-DAKOTA	5454576	3436873	3574596	3554465	3786136
TENNESSEE	5134012	5357206	5687043	6209301	6511272
TEXAS	10360003	9564492	10918240	11285213	12279684
UTAH	2217024	2460727	2432711	2567193	2662136
VERMONT	1110141	904145	1073160	1194106	1339977
VIRGINIA	5905462	6174366	6470235	6508617	7283961
WASHINGTON	6780402	6484737	7056038	7634750	7560119
WEST-VIRGINIA	2416000	2114912	2122600	2172623	2578717
WISCONSIN	10011586	7694345	7733538	8705658	9826873
WYOMING	1804984	1637079	1858260	1897320	2287191

	RSH72	RSH73	RSH74	RSH75	RSH76
ALABAMA	8359961	7074950	8684437	10317013	10708851
ARIZONA	5985696	64165745	6823862	7397850	8007377
ARKANSAS	6250661	6994097	8217963	9873614	10044966
CALIFORNIA	32380357	40725278	40623202	48357499	50793384
COLORADO	4093364	4192756	4210329	5514074	5690805
CONNECTICUT	2982008	3873150	3714937	4123040	4215385
DELAWARE	1449544	1570455	1661665	1886527	1891939
FLORIDA	15620422	17303695	20432973	23270202	24077677
GEORGIA	9576686	11334065	13500995	14501128	14938979
IDAHO	2959581	3025105	3315946	4726139	5908653
ILLINOIS	8623703	9477450	9844353	11038469	12157409
INDIANA	10583019	11163725	11284332	12915056	15123198
IOWA	9797816	10380067	11458409	12854035	13783513
KANSAS	7763954	8426697	9288173	10700061	13436301
KENTUCKY	7821851	6579206	6900148	7521708	7438608
LOUISIANA	9060604	10062819	11233858	12070639	14057894
MAINE	2489187	2537407	3029636	3371997	3609343
MARYLAND	3746615	3898635	4135484	4407811	4899287
MASSACHUSETTS	2212871	2059511	3080360	2648667	2423236
MICHIGAN	10583809	10792503	12117599	14899328	14379623
MINNESOTA	9720760	10122045	11396058	13095990	15113658
MISSISSIPPI	6926716	8250133	9442046	11238948	12419729
MISSOURI	8473606	8252937	9198709	10324572	10330768
MONTANA	4122677	3929269	5186256	5606771	6219044
NEBRASKA	9170700	10951168	12337964	13808291	15798493
NEVADA	1741957	1711879	2020217	2286723	2573503
NEW-HAMPSHIRE	1147473	1206024	1285886	1486416	1536699
NEW-JERSEY	7834459	6655605	8676764	9315506	7416210
NEW-MEXICO	2605428	2683511	2733588	3179807	3074366
NEW-YORK	16500742	17348198	19302796	19962392	22385635
NORTH-CAROLINA	13517012	14740001	16185668	20124158	21166595
NORTH-DAKOTA	4519227	4906487	5271400	6569606	8095533
OHIO	8604966	8950192	8882748	11695712	12454100
OKLAHOMA	6169256	6045201	6736054	7694185	7724184
OREGON	8569746	9457283	9561393	9703245	11082634
PENNSYLVANIA	8008403	8169219	8742305	9605636	10518347
RHODE-ISLAND	1491392	1567305	1678455	1701540	1855713
SOUTH-CAROLINA	3307935	4175353	4985752	7707069	7643280
SOUTH-DAKOTA	3925927	3802287	4166444	4654510	5058788
TENNESSEE	5627250	6227851	6976155	7914385	8470589
TEXAS	15251373	16312888	17326805	21007426	21126427
UTAH	2984181	2899138	3602257	4126581	4496910
VERMONT	1338747	1434231	1541780	1663342	1968732
VIRGINIA	7173517	8192430	9657879	10717849	11508556
WASHINGTON	7297662	7953864	9965608	10126446	12569361
WEST-VIRGINIA	2423451	2625072	2737983	2959929	3152192
WISCONSIN	11328177	13208161	14418432	14580313	15662996
WYOMING	2304670	2986242	2758744	2556958	2286153

	RSH77	RSH78
ALABAMA	13029458	13324794
ARIZONA	8941958	10795878
ARKANSAS	10654259	12375479
CALIFORNIA	55407488	60873910
COLORADO	18867321	14724592
CONNECTICUT	4581658	4952393
DELAWARE	2150080	2194657
FLORIDA	28151576	31819622
GEORGIA	15529315	18019304
IDAHO	6498687	7121848
ILLINOIS	12099761	12700688
INDIANA	15964957	17121653
IOWA	15789101	16620899
KANSAS	14700960	15247777
KENTUCKY	8092700	8886033
LOUISIANA	15137260	17431369
MAINE	4115623	4457215
MARYLAND	5265062	5808171
MASSACHUSETTS	3081367	3483002
MICHIGAN	16229043	17871755
MINNESOTA	18631451	22022837
MISSISSIPPI	13095779	14385208
MISSOURI	11530058	12271773
MONTANA	7446236	7524436
NEBRASKA	18666295	18979042
NEVADA	2905339	3139253
NEW-HAMPSHIRE	1800792	2062767
NEW-JERSEY	8958403	9269287
NEW-MEXICO	3647640	3678379
NEW-YORK	25463584	29351140
NORTH-CAROLINA	23745612	26533740
NORTH-DAKOTA	8732306	9491649
OHIO	15563187	18112715
OKLAHOMA	9154047	10204874
OREGON	13028212	14858969
PENNSYLVANIA	10333815	11432415
RHODE-ISLAND	2080171	2212941
SOUTH-CAROLINA	9073887	9584057
SOUTH-DAKOTA	6519777	5905433
TENNESSEE	8956603	11945285
TEXAS	25662720	27667450
UTAH	5067266	5893792
VERMONT	1855034	1936126
VIRGINIA	13300462	13815410
WASHINGTON	13839139	15085190
WEST-VIRGINIA	3476201	3757372
WISCONSIN	17365635	19169575
WYOMING	2890355	2984549