# PREDICTIONS OF THE FARM LABOR FORCE*

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## I. Introduction

The farm problem has long been thought to be associated with overemployment in agriculture.[1/] Because of the importance of this human resource, accurate measurement and prediction of the number of farmers and of farm work done is essential. Many farm policy decisions rely heavily on quantitative predictions which directly or indirectly involve farm employment estimates. These predictions may directly utilize the farm employment estimates in total or in some component of the labor force. Indirect measures are equally important as yardsticks of the relative efficiency of agriculture as compared with other years and with nonagricultural sectors of the economy. Typical of these measures are output per man-hour, income per farm worker, and the number of persons supported by the production of one farm worker.

In all of the predictions and estimates involving farm work, the underlying (and usually tacit) assumption is that the "best" farm employment data are used. However, several farm employment data sources exist and may be employed. None are completely satisfactory. The purpose of this paper, then, is to (1) present some longer run predictions of the farm labor force, (2) to summarily list and compare the major farm employment series, and (3) to examine the effects of the use of the different data sources on both current and the longer run estimates of farm labor. This paper is part of a larger study on measurement and prediction of the labor input.

## II. Comparison of the Sources of Farm Employment Data

The major sources of data on farm employment are: (1) employment estimates of the Statistical Reporting Service of the U. S. Department of Agriculture as published in Farm Labor;[2/] (2) estimates published by the U. S. Department of Labor in the Monthly Report on the Labor Force;[3/] (3) man-hour

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1/ Johnson, D. Gale, "The Dimensions of the Farm Problem," Problems and Policies of American Agriculture, assembled and published under the sponsorship of the Iowa State University Center for Agricultural Adjustment, Ames, Iowa, Iowa State University Press, p. 47, 1959.

2/ U. S. Department of Agriculture, Statistical Reporting Service, Farm Labor.

3/ U. S. Department of Labor, Monthly Report on the Labor Force.

requirements estimated by the Economic Research Service of the U. S. Department of Agriculture;[4] and (5) estimates of the hired farm working force of the Economic Research Service of the U. S. Department of Agriculture based on a survey conducted by the Bureau of the Census.[5] A rough estimate of the number of available farm workers also may be derived from farm population estimates.

More extensive description and comparisons of these series are contained in an earlier publication, Demand for Labor in Agriculture,[6] and other sources.[7]

The three series most commonly used are those from the Statistical Reporting Service (SRS), the Monthly Report of the Labor Force (MRLF), and the man-hour requirements of the Economic Research Service (ERS).

The series of the SRS and MRLF present employment data in terms of numbers of farm workers and are compared in the following tables and comparison summary. These series differ from the man-hour estimates in that the former are based on sample survey data. The ERS figures are derived from farm enterprise studies expanded by actual output data. This series estimates the number of man-hours that would be required for annual farm output.

The SRS and MRLF series purport to measure the same thing: numbers of farm workers. However, the tables following show considerable difference between the series, with the MRLF about 25 per cent less than SRS in the 1962 annual averages, and a mixed pattern of seasonal variation in the monthly comparison of hired labor. As listed in the monthly data comparison, the ERS hired farm work force is similar to the MRLF since the ERS data is collected on one of the Census Bureau surveys. A limitation of the series is that the data is collected in January for the prior twelve months, thus necessitating a memory recall bias for the earlier months.

Discrepancies between the SRS and MRLF series exist because of differences in concept and method of enumeration. The SRS series, due to the establishment method, essentially estimates the number of farm jobs, while the MRLF series estimates the number of farm workers.

In an attempt to quantify the differences in the two series, the following data are presented which may be compared with the annual farm employment series:

(1) The establishment method leads to double counting, since a person may hold more than one job during the survey

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4/ U. S. Department of Agriculture, Economic Research Service, Changes in Farm Production and Efficiency, U. S. Department of Agriculture Statistical Bulletin 233, revised 1962.

5/ Baum, S., Friend, R., and Stansberry, R., Jr., The Hired Farm Working Force of 1961, U. S. Department of Agriculture, Agricultural Economics Report No. 36, 1963.

6/ Johnson, Stanley S., and Heady, E. O., Demand for Labor in Agriculture, Iowa State University, CAEA 13T, 1962.

7/ U. S. Department of Agriculture, Major Statistical Series of the U. S. Department of Agriculture, How They Are Constructed and Used, Volumes 1-7, U. S. Department of Agriculture, Agricultural Handbook 118, 1957; Johnson, D. G. and Nottenburg, M. C., "A Critical Analysis of Farm Employment Estimates," Journal of American Statistical Association, 46:191-205, 1951.

Table 1. Annual average of total farm employment in the United States from Monthly Report on the Labor Force and Statistical Reporting Service series and differences, 1940-62

| Year | MRLF[a/] | SRS[b/] | Excess of SRS over MRLF series |
|---|---|---|---|
| | (Thousands of persons) | | |
| 1940..... | 9,540 | 10,979 | 1,439 |
| 1941..... | 9,100 | 10,669 | 1,569 |
| 1942..... | 9,250 | 10,504 | 1,254 |
| 1943..... | 9,080 | 10,446 | 1,366 |
| 1944..... | 8,950 | 10,219 | 1,269 |
| 1945..... | 8,580 | 10,000 | 1,420 |
| 1946..... | 8,320 | 10,295 | 1,975 |
| 1947..... | 8,266 | 10,382 | 2,116 |
| 1948..... | 7,973 | 10,363 | 2,390 |
| 1949..... | 8,026 | 9,964 | 1,938 |
| 1950..... | 7,507 | 9,926 | 2,419 |
| 1951..... | 7,054 | 9,546 | 2,492 |
| 1952..... | 6,805 | 9,149 | 2,344 |
| 1953..... | 6,562 | 8,864 | 2,302 |
| 1954..... | 6,504 | 8,639 | 2,135 |
| 1955..... | 6,730 | 8,364 | 1,634 |
| 1956..... | 6,585 | 7,820 | 1,235 |
| 1957..... | 6,222 | 7,577 | 1,355 |
| 1958..... | 5,844 | 7,525 | 1,681 |
| 1959..... | 5,836 | 7,342 | 1,506 |
| 1960..... | 5,723 | 7,057 | 1,334 |
| 1961..... | 5,463 | 6,919 | 1,456 |
| 1962..... | 5,190 | 6,700 | 1,510 |

a/ Source: U. S. Department of Labor, Employment and Earnings, Vol. 9, No. 10, April 1963.

b/ Source: U. S. Department of Agriculture, Agricultural Marketing Service, Farm Employment, U. S. Dept. Agr. Stat. Bul. 236, 1958; U. S. Department of Agriculture, Statistical Reporting Service, Farm Labor, March 11, 1963, and Jan. 1959.

Table 2. Average employment of hired farm workers by months, United States, Statistical Reporting Service, Monthly Report on the Labor Force, and the hired farm working force series, 1957

| Month | SRS[a/] | MRLF[b/] | HFWF[c/] | |
|---|---|---|---|---|
| | | | Original | Adjusted[c/] |
| | (Thousands of persons) | | | |
| January..... | 896 | 1,154 | 757 | 827 |
| February..... | 1,040 | 1,180 | 768 | 839 |
| March..... | 1,284 | 1,209 | 856 | 935 |
| April..... | 1,543 | 1,322 | 1,085 | 1,177 |
| May..... | 1,985 | 1,710 | 1,394 | 1,538 |
| June..... | 2,684 | 2,138 | 1,924 | 2,058 |
| July..... | 2,983 | 2,354 | 2,189 | 2,364 |
| August..... | 2,883 | 1,971 | 2,058 | 2,219 |
| September..... | 2,805 | 1,911 | 1,872 | 2,121 |
| October..... | 2,237 | 2,112 | 1,706 | 1,944 |
| November..... | 1,450 | 1,654 | 1,405 | 1,568 |
| December..... | 951 | 1,533 | 1,073 | 1,174 |
| Average..... | 1,895 | 1,687 | 1,424 | 1,564 |

a/ Source: U. S. Department of Agriculture, Agricultural Marketing Service, Farm Employment, U. S. Dept. Agr. Stat. Bul. 236, 1958.

b/ Source: U. S. Bureau of the Census, Current Population Reports: Labor Force, Series P-50, Nos. 72-89, March 1957-June 1959.

c/ Adjusted to include foreign workers.
Source: Maitland, Sheridan T. and Fisher, Dorothy Ann, The Hired Farm Working Force of 1957, U. S. Dept. Agr. Inform. Bul. 208, 1959.

## A COMPARISON OF SOURCES OF FARM EMPLOYMENT ESTIMATES

| USDA - SRS Series | USDL - MRLF Series |
|---|---|
| **1. Survey Week:** | |
| The last full calendar week of the month. | The week ending nearest to the 15th of the month. |
| **2. Method of Enumeration:** | |
| The "establishment" method: information is obtained about all workers on the establishment. | The "household" method: information is obtained about all workers who are actual members of the household. |
| **3. Age Limits:** | |
| Persons of all ages are included. | Only persons over 14 years of age are included. |
| **4. Work Requirements:** | |
| One or more hours of farm work for a hired worker, any work at all for an operator and 15 or more hours for unpaid family workers. | In addition to the minimum requirements, the worker must have worked longer at agricultural employment than at nonagricultural employment during the survey week. |
| **5. Nonagricultural Occupations:** | |
| None included. | Some categories of workers engaged in nonfarm occupations are included, such as bookkeepers, and persons engaged in some processing activities. |
| **6. Unemployed Workers:** | |
| None included. | Unemployed farm operators actively seeking work may be included. |

week, and which was estimated at 250,000 or more.[8]

(2) The MRLF undercounts because they do not include workers under 14 years of age. The number of these workers is estimated to be 1,000,000 seasonally.[9]

(3) Further undercounting by the MRLF is because they do not include persons with multiple jobs and who earn a larger proportion of income from nonagriculture. This may amount to 500,000 to 1,000,000 seasonally.[10]

These are the primary quantifiable differences of the two series. Other differences are not quantifiable, such as the differing dates of survey, the MRLF estimates which come from a statistically selected sample so that standard errors of the estimates can be computed, and the fact that data exist for the SRS series from 1910 and only from 1940 for the MRLF.

Hence, considerable differences exist between employment series. Use of a series without proper documentation can lead to serious misunderstanding. In this paper we do not present methods to improve these series; we ask judicious use be made of employment series that will improve communication.

## III. Long-Run Predictions of Farm Labor Demand

Several studies were compiled during the last few years which presented estimates of farm output in 1965, 1975, and 2000. In the inquiry into future requirements and supplies of agricultural products, predictions of the demand for farm labor were necessary. These predictions were made by Daly and Barton; Bonnen and Black; The President's Materials Policy Commission; Koffsky; Cochrane, and Lampe; Ruttan; Clark; and Clawson.[11] A common method in these predictions is to assess

8/ U. S. Department of Agriculture, Statistical Reporting Service, Farm Labor, p. 6, February 10, 1950.

9/ U. S. Department of Agriculture, Major Statistical Series of the U. S. Department of Agriculture, op. cit. Another source estimates 2,000,000 young workers at peak periods: Johnson, D. Gale, and Nottenburg, M. C., op. cit.

10/ U. S. Department of Agriculture, Major Statistical Series of the U. S. Department of Agriculture, op. cit.

11/ See: Bonnen, J. T. and Black, J. D., A Balanced U. S. Agriculture in 1965, National Planning Association, Washington, D. C., 1956; Clark, Colin, "Afterthoughts on Paley," Rev. Econ. Stat. 36:267-273, 1954; Cochrane, W. W. and Lampe, H. C., "The Nature of the Race Between Food Supplies and Demand in the U. S., 1951-1975," Journal of Farm Economics, 35:203-222, 1953; Daly, R. F. and Barton, G. T., "Prospects for Agriculture in a Growing Economy," Problems and Policies of American Agriculture, assembled and published under the sponsorship of the Iowa State University Center for Agricultural Adjustment, Iowa State University Press, Ames, Iowa, 1959, pp. 28-46; Koffsky, Nathen, "The Long Term Price Outlook and Its Impact on American Agriculture," Journal of Farm Economics, 36:790-798, 1954; Ruttan, Vernon W., "The Contribution of Technological Progress to Farm Output: 1950-75," Rev. Econ. Stat., 38:61-69, 1956; U. S. President's Materials Policy Commission, Resources for Freedom: A Report to the President, Vol. 1-5, U. S. Government Printing Office, Washington, D. C., 1952; Clawson, Marion, "Aging Farmers and Agricultural Policy," Journal of Farm Economics, 45:13-30, 1963.

consumer needs for and projected supplies of agricultural products. Farm employment predictions are then based on these projections, the labor force assessments relating to a rigid set of conditions pertaining to full employment, population change, no war, and so on. Given these restrictions, factors affecting the rate of food consumption were listed as: (1) population growth; (2) per capita consumer income; (3) price and income elasticities; and (4) changes in world supply and demand affecting exports.

Perhaps the most important single determinant among the predictions made was the growth in population. Population predictions used for the United States in 1975 have varied according to the year of the written report because estimates of the fertility rate have changed between years. For instance, some of the population estimates were, in millions of persons: Clark,[12] 234; Koffsky,[13] 210; Paley Commission,[14] 193; Daly,[15] 215.8 to 243.9. Given a population prediction, and adjusting for income and price elasticities and foreign trade, estimates of the consumer needs of agricultural products are then made. Estimates of future production are then computed.

Finally, the estimates of the size of the farm labor force, such as for 1975, are calculated to furnish the manpower needed either to fulfill the production estimates or to meet consumer needs. Among the predictive methods used were "educated guesses," as in Bonnen,[16] and extension of linear trends as utilized by Clark.[17] A comparison of predictions of the agricultural labor force for 1975 are:[18] Daly, 5.5 million workers; Black, a decrease of at least 10 per cent in the labor force from 1950, or 8.4 million workers or less; Clark, 2 million workers.

Taken at face value, farm employment estimates range from 8.4 to 2.0 million workers. Though no source is mentioned, the employment data given by Clark suggests his use of MRLF estimates. The others apparently refer to SRS figures.

## A Long-Run Predictive Model for Farm Labor

The more common projective models utilize the method of extending trends either as the projection or in estimating determining variables. Linear extensions of trends have obvious faults.[19] However, at the extremes, complex estimational procedures may lead to projections which depart from reality, and the educated guesses need quantitative verification. We present a simple model that can be applied using available data, which takes into account changes in output per man-hour and population change, which so affected the estimates above. We first tried a logistic model, but found it difficult to estimate.

12/ Clark, Colin, op. cit.
13/ Koffsky, op. cit.
14/ U. S. President's Materials Policy Commission, op. cit.
15/ Daly, op. cit.
16/ Bonnen, op. cit.
17/ Clark, Colin, op. cit.
18/ Daly, op. cit., Bonnen, op. cit.; Clark, Colin, op. cit.
19/ Clark, Colin, op. cit.

The model used for long-run prediction in this paper is derived from a growth model similar to that proposed by Hicks.[20] Hick's model is:

$$(76)\quad E_n = E_o\ (1 + g)^n$$

where g = the growth rate, $E_o$ = equilibrium output in period 0, and n = the n-th time period. This model is one with a constant growth rate, causing the function to change at an increasing rate. The farm labor force in the United States has been, and is expected to continue, decreasing in size. To predict farm labor force size, the equation was altered so that the function decreases at a decreasing rate, as follows:

$$(77)\quad M_n = M_o(1 - p)^n$$

where $M_n$ = man-hour requirements (or numbers) of agricultural labor in the year n, $M_o$ = man-hour requirements (or numbers) in the base year, and p = the rate of change of agricultural output per man-hour. Since output will change according to consumer needs, estimated change in total United States population was added to the model as follows:

$$(78)\quad M_n = M_o(1 - p)^n(1 + g)^n$$

where g = the yearly average change in population in the United States, and the other parameters are the same as explained above. We have to assume a passive effect of price and income elasticities and foreign trade.

The advantages of a model of this type are: (1) projections are a function of farm man-hours (or numbers of farm workers) in the present or some base year; (2) the equation may be modified as man-hour productivity changes; (3) the model can consider growth in the consumer sector; and (4) algebraically, when g = 0, the model allows "slow" convergence to some lower asymptote, zero, with the rate of convergence subject to estimated productivity.[21] Our 1975 projections are for man-hour requirements in agriculture, and for farm labor employment as measured by both SRS and MRLF.

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20/ Hicks, J. R., A Contribution to the Theory of the Trade Cycle, Oxford University Press, London, England, 1950.

21/ When $g \neq 0$, the model may become explosive. Consider

$$\lim_{n \to \infty} M_n = \lim_{n \to \infty} M_o\ (1 - p)^n(1 + g)^n.$$

Now $M_o$ is a constant base value and filters through the limit operator. Then

$$\lim_{n \to \infty} M_n = M_o \lim_{n \to \infty} [\,(1 - p)(1 + g)]^n$$

If $(1 - p)(1 + g) = 1$, then $M_n = M_o$ for all n. But if $(1 - p)(1 + g) > 1$, then $M_n$ explodes. In the more likely case, if $(1 - p)(1 + g) < 1$, it converges to zero. Note that we assume $-1 < P$ or $q < 1$.
In the case where $(1 - p)(1 + g) < 1$, and solving for p, we get convergence to zero in the cases when

$$p > \frac{g}{1 + g},$$

and explosion when

$$p < \frac{g}{1 + g}.$$

(Footnote Continued Next Page)

A convenient method used in estimating p (let us call it the change in farm productivity) was to determine the average yearly rate of change in farm man-hour requirements (or in farm employment estimates) for the last few years. Thus, for man-hour requirements, we substitute in various years from 1946 to the present for $M_n$ and $M_o$ to determine an average value for p. For instance, the estimate of p for 1961 is

$$89 = 92\ (1 - p)^1(1 + g)^1$$

where g is estimated to be 0.017. Taking the logarithms of both sides and solving, we have p = 0.035. Similarly, the values of p for 1957 through 1960 were determined, and an average value for p was 0.058. In order to predict, the value of p was substituted into the equations for 1975, using 1961 as the base period. The resultant point estimates are in index form, based on the 1957-59 average of man-hour requirements. The United States farm man-hour "needs" in 1975 are thus estimated to be 48.8 per cent of the 1957-59 average. Estimates from the equation are plotted and compared with a linear trend in the accompanying figure.

With increasing technology and greater labor productivity, and a greater demand for leisure, one would anticipate that man-hour requirements tend to decrease more rapidly than the number of farm workers. By utilizing SRS and MRLF series, predictions of farm employment were derived. The number of farm workers estimated for 1975 were 2,660,000 based on MRLF data and 4,401,000 from SRS data. These estimates are 45 and 59 per cent, respectively, of 1957-59 averages. Hence, there was no indication of any pronounced shift in man-hour requirements away from the MRLF and SRS predictions as based on the 1957-61 average change in man-hour requirements.

Since "p," if we can loosely call it the productivity of labor, is not constant over long periods of time, frequent testing of the yearly changes in man-hour requirements with a concomitant adjustment in the long-run estimates thus is recommended in use of projections such as those above.

## IV. Effects of the Use of Different Employment Series

The effect of direct use of different farm employment series is obvious from a glance at the various estimates. The SRS and MRLF series vary considerably, but at least they are in the same unit of measurement. The ERS series can be compared only by putting all series in index form. One example of a misunderstanding because of lack of explicit documentation of a series is the prediction of the farm labor force in 1975 by C. Clark.[22] His use of the MRLF series made a comparison of employment estimates even more difficult.

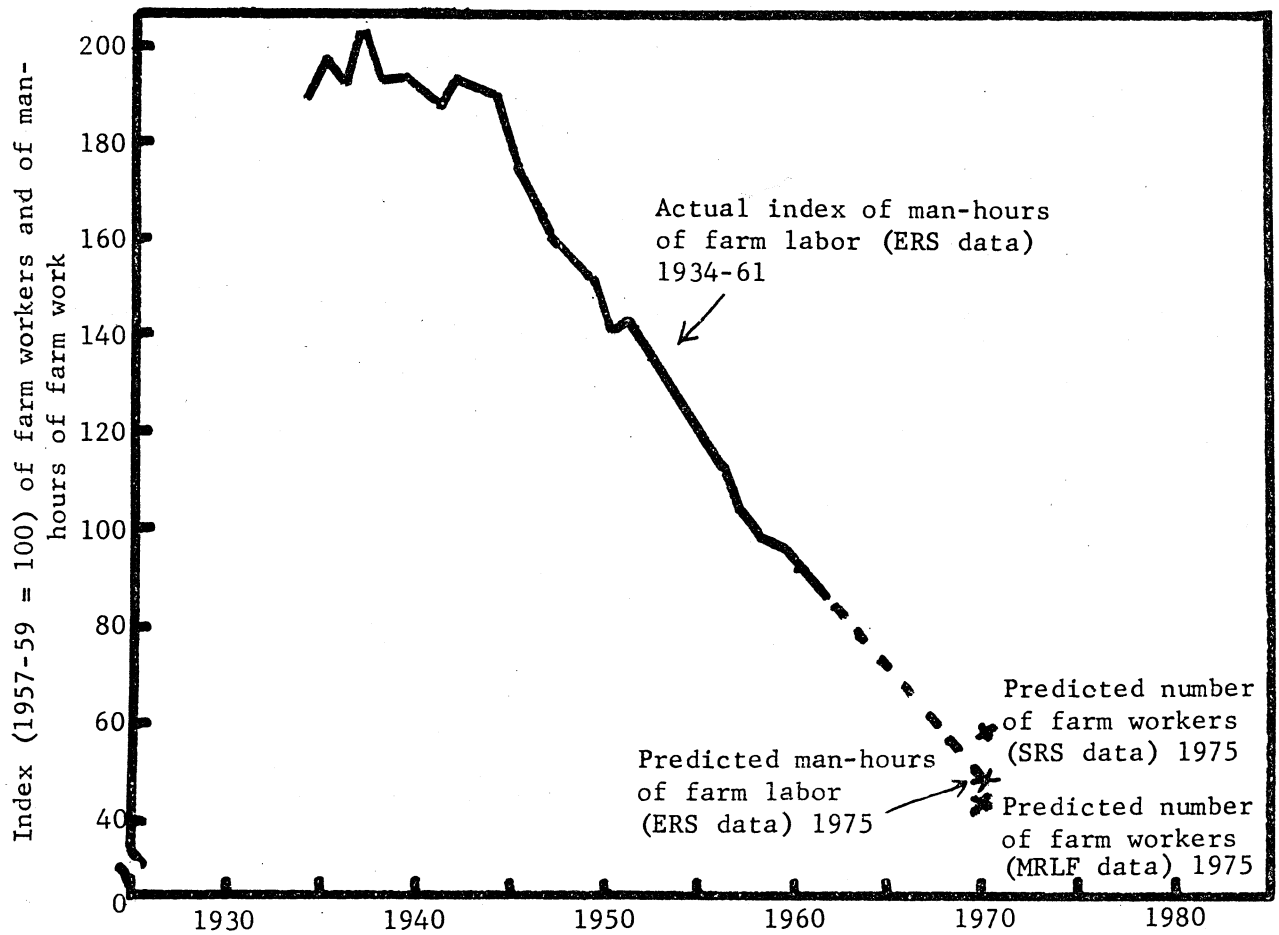
The most difficult cases arise upon use of these series in an indirect manner. For instance, we wish to compare income per farm worker with income per

21/ Cont. - The population increase has been upward at the rate of about 1-3/4 per cent per annum, so that p needs to be greater than 0.0175/1.0175 or p> 0.017 for convergence. Our estimates of p range from 0.035 to 0.066.

22/ Clark, C., op. cit.

Index (1957-59 = 100) of farm workers and of man-hours of farm work

FIGURE 1. Predictions of agricultural man-hour requirements and number of farm workers for the United States, 1961-75.




SOURCE: U.S. Department of Agriculture, Economic Research Service, Change in Farm Production and Efficiency, U. S. Department of Agriculture Statistical Bulletin 233, Revised July 1963, p. 34, Washington, D. C., See text for predicted data.

nonfarm worker.[23] For 1961, the net income from farming was estimated to be $15,851 millions. The Farm Income Situation uses the SRS figure of 6,990,000 farm workers to arrive at the average annual farm income per worker of $2,268. One can then compare this figure with annual wage per employed factory worker of $4,802. Now, however, if we use the MRLF series for 1961, 5,463,000 persons, we obtain an annual farm income per worker of $2,902, an increase of 28 per cent over the prior figure.

Similarly, let us accept the 1975 estimate of farm output to increase 41 per cent over the 1956-57 average.[24] Given the 1975 estimates of farm employment we can construct a measure of the 1975 output per farm worker. Based on SRS data, with output increasing 41 per cent over 1956-57 and employment dropping to 4,401,000 workers, output per worker would rise to 246 per cent of 1956-57. However, using the MRLF employment figure for 1975, output per worker would rise to 340 per cent of the 1956-57 average.

In conclusion, we have presented a brief comparison of farm employment estimates. Utilizing these estimates, we employed them in a simple long-run predictive model. Finally, we have tried to point out a few of the misunderstandings that may arise because of lack of communication on the basic employment series used.

In the next phase of the study, analyses of data and predictions of shorter run will be conducted.

23/ U. S. Department of Agriculture, Economic Research Service, Farm Income Situation, p. 45, July 1962.
24/ Daly, R. F., op. cit., p. 38.