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## A PREDICTIVE MODEL FOR MANPOWER REQUIREMENTS IN GEORGIA AGRICULTURE\*

H. Evan Drummond and Fred C. White

Persistently high levels of unemployment among unskilled workers, as well as college graduates, have focused attention on manpower problems. High levels of unemployment may result from a deficiency of aggregate demand or from structural maladjustments in the manpower market. The latter problems generally emanate from changing technological patterns and shifts in the pattern of economic growth. While there are many socio-economic issues involved, it is generally recognized that problems of structural adjustment can be satisfactorily managed, in time, if a sufficiently high level of aggregate demand is maintained. Therefore, an initial concern in manpower planning is to accurately relate manpower requirements by occupation and level of education to anticipated levels of aggregate demand.

Manpower planning with particular emphasis on the agricultural sector continues to be inadequate, even though the labor market in agriculture has been a particularly unstable segment of the total labor market for the past generation. Two basic factors which have tended to generate relatively high rates of unemployment and underemployment in agriculture are the substitution of capital for labor and the extension of minimum wage coverage to include farm workers. While these factors provide a partial elucidation of the manpower problems confronting agriculture, it is clear that the manpower requirements of agriculture in the coming decade will depend not only on factors that affect labor productivity, but also on the general level of economic activity and the rate of labor turnover in agricultural occupations.

Effective and efficient manpower policy depends upon an accurate assessment of aggregate demand and

of the structural requirements implied by that aggregate demand. The general objective of this paper is to develop an economic model of manpower requirements that may be utilized to estimate future structural patterns of manpower requirements in agriculture. The specific objectives of the research upon which this paper is based are:

1. To project agricultural manpower requirements in Georgia for 1980;
2. To estimate the retained manpower that will be available and the number of new entrants into the agricultural labor force necessary to satisfy estimated manpower requirements, and
3. To examine the anticipated occupational structure and educational attainment of new entrant requirements.

### THE MODEL

The conceptual model employed in this study consists of three major components. In the first component, manpower requirements for the state are related to a projected level of economic activity, labor productivity and occupational structure. The concept of manpower requirements does not relate employment levels to the determination of equilibrium of supply and demand in the labor market. Instead, manpower requirements refers to the relationship between employment and aggregate demand. Stated simply, manpower requirements is the level of occupational employment needed to produce a specified level of output.

The second part of the model is designed to project manpower retention. By manpower retention

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\*Oklahoma State Agricultural Experiment Station Journal Article No. J-2812.

we mean that portion of the labor force in time period  $t$  that continues in the state labor force to time period  $t+1$ . Finally, estimates will be made to determine the number of new entrants into the manpower pool that will be needed in time period  $t+1$  in order to satisfy the gap between manpower requirements and manpower retention. These estimates will be further refined to show the distribution of new entrants by level of educational attainment and occupational category.

### Manpower Requirements

Georgia's manpower requirements in future time periods are dependent on the level of total economic activity. Input-output techniques which account for differential rates of growth in each sector of the economy may be used to project the level of economic activity. Estimates of future output levels using input-output techniques have proven to be extremely accurate, particularly for regional economies in the short run [1, Ch. 8; 2, Ch. 3, 4]. If it is assumed that the previously determined  $a_{ij}$  in equation (1) are constant with respect to time, then the total output of each sector in time period  $t$  is solely dependent on the level of final demand in  $t$ :

$$(1) \quad TO_i^t = \sum_{j=1}^n a_{ij} FD_j^t$$

where:

- $TO_i^t$  is total output in value in sector  $i$  in time period  $t$ ,  
 $a_{ij}$  is the interdependence coefficient which indicates the amount of production from sector  $i$  necessary to sustain a final demand of one dollar in sector  $j$ , and  
 $FD_j^t$  is final demand for the products of sector  $j$  in time period  $t$ .

Manpower requirements are directly related to sectoral output levels. For a given time period  $t$ , the occupational structure of the labor requirements is given by:

$$(2) \quad E_i^t = TO_i^t / P_i^t \quad (3) \quad O_k^t = \sum_{i=1}^n E_i^t b_{ki}^t$$

where:

- $E_i^t$  is employment in sector  $i$ , time period  $t$ ,

- $P_i^t$  is average labor productivity in sector  $i$ , time period  $t$ ,  
 $O_k^t$  is the manpower requirement in occupational category  $k$ , time period  $t$ , and  
 $b_{ki}^t$  is the proportion of total manpower requirements in sector  $i$  to be filled by occupational category  $k$ , time period  $t$ .

Equations (2) and (3) show that occupational requirements are dependent on the aggregate level of output, productivity in each sector of the economy, and the occupational structure within each industry. Given estimates of these variables for any time period  $t$ , manpower requirements by occupational category in  $t$  are easily projected by the system of equations (1)-(3).

### Retained Manpower

During any given time period the total manpower pool is diminished as workers retire, leave the state, or are otherwise separated from the labor force. Also, workers transfer among occupational categories. As a result of these disturbances, the retained manpower that is available in time period  $t$  is smaller and structurally different from that which existed in time period  $t-1$ .

The total manpower retained within the state in time period  $t$  is equal to the total at the end of time period  $t-1$  minus out-migration and labor force separation. These rates are calculated for each occupational category and by sex:

$$(4) \quad P_{sk}^t = O_{sk}^{t-1} [1 - c_{sk} - d_{sk}]$$

where:

- $P_{sk}^t$  is the Georgia manpower from time period  $t-1$  retained within the state in  $t$  by the worker's occupation  $k$  in  $t-1$  and sex  $s$ ,  
 $c_{sk}$  is proportion of total manpower that is expected to retire, die, or otherwise leave the manpower pool between  $t-1$  and  $t$  by occupation  $k$  in  $t-1$  and sex  $s$ ,  
 $d_{sk}$  is the proportion of total manpower that is expected to migrate out of the state between  $t-1$  and  $t$  by occupation  $k$  in  $t-1$  and sex  $s$ , and  
 $O_{sk}^{t-1}$  is employment by occupation  $k$ , in time period  $t-1$ , by sex  $s$ .

The occupational structure of this portion of retained manpower also depends on the nature of interoccupation transfers that occur between  $t-1$  and  $t$ . The retained manpower available in  $t$  from each occupational category will be:

$$(5) \quad V_{sk}^t = \sum_{m=1}^n [e_{skm} P_{sk}^t]$$

where:

$V_{sk}^t$  is the Georgia manpower from time period  $t-1$  retained within the state in  $t$  by the worker's occupation  $k$  in  $t$  and sex  $s$ , and

$e_{skm}$  is the proportion of the workers by sex  $s$  in occupation  $m$  in time period  $t-1$  that will transfer to occupation  $k$  in  $t$ .

To some extent, in-migrants offset the effects of out-migrants. In-migration is a function of the need for additional manpower as measured by the difference between net retained manpower within the state and projected manpower requirements in each occupational category:

$$(6) \quad M_{sk}^t = f_{sk} [O_{sk}^t - V_{sk}^t]$$

where:

$M_{sk}^t$  is the number of workers in the labor force outside of Georgia in period  $t-1$  that have entered the Georgia labor force by  $t$ , by occupation  $k$  and sex  $s$ , and

$f_{sk}$  is the proportion of total manpower deficit filled by in-migrants already in the labor force.

Total retained manpower available for employment is the sum of Georgia retained manpower and in-migrants:

$$(7) \quad R_k^t = \sum_{s=1}^2 [V_{sk}^t + M_{sk}^t]$$

$R_k^t$  is the total manpower retained in time period  $t$  from the labor force that existed in  $t-1$ , by occupational category in  $t$ .

## Required Entrants

The manpower by occupational category required to sustain the level of aggregate demand projected for time period  $t$  has been estimated to be  $O_k^t$ . The manpower from time period  $t-1$  that will be retained in  $t$  is  $R_k^t$ . In general, manpower requirements increase with time while retained manpower decreases. The difference between the two must be filled by new labor force entrants if the projected level of economic activity is to be sustained. Equations (1)-(7) show that the number of new entrants required in each occupational category is dependent on final demand, labor productivity, and the structural characteristics of the aggregate labor market in Georgia.

## ESTIMATION PROCEDURES<sup>1</sup>

Manpower and entrant requirements for 1980 in Georgia were estimated by the above model with 1970 as a base year. The input-output model used for this study was recently prepared by Shaffer, et al., for the Georgia Department of Industry and Trade [5, 6]. Projected final demand for Georgia was based on historical growth rates. It was assumed that each component of final demand would continue to expand in the coming decade at its average annual national rate of real growth over the quinquennium 1966-1971. All projections are in constant 1970 dollars.

Rates of change in labor productivity for each sector were used to calculate projected productivities for 1980 [3]. The 1970 occupational structure was taken from Census data [7] and adjusted for 1980 in accordance with predictions by the Bureau of Labor Statistics [8].

Data used in equations (4)-(7) to estimate the number of workers that would be retained in the labor force in 1980 were taken from recent Census reports. Estimates of withdrawals from each occupation by virtue of retirement or death were based on the age and sex distributions of workers in each occupation as reported in the Census. Estimates of migration rates and movement of workers among occupations were based on data from 1965-1970. These rates were assumed to remain constant during the 1970-1980 decade.

The number of labor force entrants is simply the difference between the manpower required in each period and the manpower retained from the previous period. Assuming that the 1970 structure of

<sup>1</sup> A more complete description of data sources and estimation procedures is available from the authors on request.

**Table 1. TOTAL OUTPUT AND EMPLOYMENT BY SECTOR IN GEORGIA, 1970 AND PROJECTED 1980**

| Sector                  | Output                    |        |          | Employment        |           |          |
|-------------------------|---------------------------|--------|----------|-------------------|-----------|----------|
|                         | 1970 <sup>a</sup>         | 1980   | % Change | 1970 <sup>b</sup> | 1980      | % Change |
|                         | -----million dollars----- |        |          | -----number-----  |           |          |
| Agricultural Production | 1,477                     | 2,374  | 60.73    | 75,521            | 69,061    | -8.55    |
| Food Processing         | 2,281                     | 3,633  | 59.27    | 41,143            | 46,441    | 12.88    |
| Other Sectors           | 32,061                    | 49,174 | 53.38    | 1,630,105         | 1,955,894 | 19.99    |
| Total                   | 35,819                    | 55,181 | 54.06    | 1,746,769         | 2,071,396 | 18.58    |

<sup>a</sup>Source: 1970 data from the *U.S. Census of Population, 1970*, Table 180, Georgia Detailed Characteristics.

<sup>b</sup>Source: 1970 data from Shaffer [5].

**Table 2. EMPLOYMENT BY OCCUPATION BY SECTOR IN GEORGIA, 1970 AND PROJECTED 1980\***

| Occupation              | Agricultural Production<br>Employment |        | Food & Processing<br>Employment |        | Total<br>Employment |         | Percentage<br>Change |
|-------------------------|---------------------------------------|--------|---------------------------------|--------|---------------------|---------|----------------------|
|                         | 1970                                  | 1980   | 1970                            | 1980   | 1970                | 1980    |                      |
| Professional, Technical | 2,584                                 | 4,073  | 1,599                           | 2,329  | 4,183               | 6,402   | 53                   |
| Managers                | 888                                   | 1,127  | 2,647                           | 2,912  | 3,535               | 4,039   | 14                   |
| Sales Workers           | 267                                   | 138    | 1,838                           | 2,107  | 2,105               | 2,425   | 15                   |
| Clerical                | 1,374                                 | 1,580  | 3,988                           | 4,682  | 5,362               | 6,262   | 17                   |
| Craftsmen               | 1,277                                 | 2,199  | 5,033                           | 5,775  | 6,310               | 7,974   | 26                   |
| Operatives              | 2,327                                 | 2,900  | 21,180                          | 24,470 | 23,507              | 27,370  | 16                   |
| Non-Farm Laborers       | 4,688                                 | 5,370  | 3,265                           | 2,456  | 7,953               | 7,826   | -2                   |
| Farm Workers            | 61,526                                | 50,792 |                                 |        | 61,526              | 50,792  | -17                  |
| Service Workers         | 590                                   | 701    | 1,593                           | 1,710  | 2,183               | 2,411   | 10                   |
| Total                   | 75,521                                | 69,061 | 41,143                          | 46,441 | 116,664             | 115,502 | -1                   |

\*Source: 1970 data from the *U.S. Census of Population, 1970*, Table 180, Georgia Detailed Characteristics.

educational attainment by occupation [7] remains constant for the following decade, it was also possible to compute the number of entrants required at each educational level by occupation.

### RESULTS

The model described above is capable of projecting output and employment for all sectors and occupational categories simultaneously. Our discussion will be limited to those aspects of the model that are of particular relevance to manpower planning in agriculture. Those segments of the agricultural sector which are emphasized in this study are agricultural production and food processing. The

projections of output and employment for these two sectors in Georgia for 1980 are summarized in Tables 1 and 2.

As shown in Table 1, the value of production generated by both the agricultural production and food processing sectors is projected to increase at a rate faster than the remainder of the economy. Total output in the two sectors should increase by 60 percent over the decade. In spite of a rapid expansion of output, employment in both sectors is projected to expand less rapidly than the economy as a whole, due to relatively high levels of projected productivity increases. By 1980 employment in agricultural production will fall to just over 90 percent of its

1970 level. While an increase in employment in the food processing sector is projected, the rate of employment increase in this sector is only two-thirds that projected for the total Georgia economy.

The implications of these projections for specific occupational groups are shown in Table 2. While the total employment in the two sectors will remain about the same, there will be a significant redistribution of the agricultural labor force among occupational categories. As might be expected, the number of farm workers (managers plus laborers) will fall (by more than 10,000 workers), while the professional, technical and craftsmen occupations will demonstrate significant expansions.

As shown in Table 3, the agricultural production and food processing sectors combined will require 67,397 new entrants during the decade. Of this total, slightly more than 34,000 required entrants will be farm workers. This is a relatively high entrant requirement in light of our projection that the number of farm workers will have declined to just over 50,000 by 1980. This apparent paradox results from a very high rate of turnover (separation and interoccupation transfers) in the occupational category of farm workers. Presumably, few of the individuals employed as farm workers in 1970 will continue in that employment throughout the decade.

The estimated level of educational attainment of required entrants in each occupational category is also presented in Table 3. Of the total 67,000 entrants required in the agricultural sectors during the next 10 years, only slightly more than 5,000 will require training beyond a basic high school education. The remaining 62,000 entrants will enter the agricultural labor force with 12 or fewer years of education.

## IMPLICATIONS

These empirical results have definite implications regarding manpower planning in Georgia. The particular advantage of our model from the point of view of manpower planners is that the number of entrants required in each occupation is projected as well as the total level of employment. Entrant requirements by occupation do not necessarily correlate with changes in the level of employment due to differences in separation rates and interoccupation transfer rates. Consequently, education and manpower planners must consider turnover rates, as well as growth rates, if accurate projections of entrant requirements are desired.

The rapid turnover among farm workers in Georgia leads us to raise two related questions concerning manpower training for farm workers. First, are improvements or modifications in manpower training programs and/or education system needed to reduce the high rate of farm worker turnover? Certainly, the social and private costs associated with labor turnover justify further investigation of the high rate of farm worker turnover. A second question that merits discussion is whether any specific manpower and/or educational program should be designed for farm workers when a high rate of turnover is anticipated. Previous research has shown that the expected economic return to agribusiness vocational programs is well below that of many alternative manpower training programs [4]. An efficient allocation of the scarce resources available for manpower programs may very well exclude the training of farm workers for employment in the agricultural sectors.

Even though agricultural production and food processing do not include all agribusiness firms that

Table 3. ENTRANTS NECESSARY BETWEEN 1970-1980 TO SATISFY PROJECTED MANPOWER REQUIREMENTS IN AGRICULTURAL PRODUCTION, AND FOOD PROCESSING BY OCCUPATION, BY LEVEL OF EDUCATIONAL ATTAINMENT: GEORGIA

| Occupation              | 1970-80<br>Entrants | 1970-80 Entrants by Level of Education |                  |                    |
|-------------------------|---------------------|--|------------------|--------------------|
|                         |                     | 0-12 yrs.                              | 1-3 yrs. college | 4 or more, college |
| Professional, Technical | 2,910               | 806                                    | 564              | 1,542              |
| Farm Workers            | 34,010              | 32,252                                 | 1,156            | 602                |
| All Others              | 30,477              | 28,993                                 | 1,240            | 241                |
| Total                   | 67,397              | 62,051                                 | 2,960            | 2,385              |

might demand graduates of a college of agriculture, those responsible for planning Georgia's higher education programs in agriculture might be interested in the results shown in Table 3. The total demand for college graduates by these two agricultural sectors will average about 240 entrants per year. Demand for these college graduates must be balanced against the supply of graduates. Merely as a point of reference, it should be noted that from 1969 to 1973, an annual

average of 240 students received undergraduate degrees in agricultural production and related fields from the University of Georgia College of Agriculture. A further analysis and appraisal of the manpower requirements within the general framework we have employed in this study should serve to further coordinate university programs in agriculture with the realities of the labor market.

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