Vegetable growers recently have been concerned over the shortage and high cost of farm labor. The high cost is due largely to the inability of available labor to do the job before them. The result has been not only high wages but also many valuable food crops left in the fields to rot.

There are two direct ways of easing this problem: (1) Import more labor; (2) Find methods to increase the output of our present labor. The door to the first approach is nearly closed, but the opportunity for increasing our workers' efficiency is great.

Not long ago, industry was faced with a similar problem of unskilled labor and high wages. There was little hope or desire to reduce wage rates. The alternative was to find ways in which labor could yield more output per man, not through harder work or longer hours, but by technological progress and simplified methods of work. Industrial engineers stepped in and learned to analyze a job much as a chemist breaks down a compound. Every movement in performing a job was studied and the most economical methods developed. Improvements were continually sought and made.

Last year the General Education Board made financial grants to a number of State Universities for the purpose of beginning research in the field of agricultural labor methods. The work of industrial engineers was to form the basis for this new research. This paper is presented for the purpose of illustrating some of the things accomplished in this work as well as to demonstrate future possibilities of such methods.

The work in Florida has dealt largely with vegetable production and harvesting. Some moving pictures have been made of labor saving devices. Motion and time studies were made of pulling carrots, tying staked tomatoes, covering celery seedbeds, picking tomatoes, and other operations. By pulling carrots with both hands instead of one, as is the common practice, it was found that a worker could pull 47 percent more carrots without working under greater strain. A simplified method of tying tomatoes enables 5 workers to do the work of 6 with less motion. The labor for covering celery seedbeds was reduced over 25 percent by a re-arrangement of the covers. Most of the tomatoes in this States are harvested by workers picking with one hand, but workers paid an incentive wage use both hands and pick nearly twice as many tomatoes.

Such studies as these were interesting to the grower, but many growers still felt that based on their experience they were doing the job either the best or only way it could be done. In speaking of new ideas, the statements, "It won't work; it sounds all right, but it just won't work," and the statement, "You'll never be able to make my workers do it that way," were commonly heard. There may be a little truth in both statements. However, the idea behind work simplification is not to "make" workers do it a particular way but rather to show them that they can do the job a simpler, easier way.

Because some growers were found already using ideas which had been developed analytically, it was decided to undertake a comparative type of study between a number of successful growers doing the same job in different ways and then fill the gaps with motion analyses where needed. Such a
study was made of 9 organizations harvesting and packing celery. It will be used here as an example. The methods of making this study will not be discussed other than to say every detail, from cutting in the field to packing in the warehouse, was carefully observed. Moving pictures, stop watches, and hand counters were used. Every precaution was taken to get accurate comparisons between organizations.

The completed study revealed a difference of over 100 percent in the amount of field labor used between the most and the least efficient organizations. Washhouse labor varied 136 percent. For combined field and washhouse operation some organizations were using over 50 percent more manpower per unit of 10,000 stalks handled than others. The detailed timing data for every class of worker revealed where the efficiencies and the inefficiencies were. Observation in the field gave the reasons. Some organizations were extravagant in stripping celery or in cutting roots, or packing, or topping, loading, or re-stripping. To strip 10,000 stalks one organization required less than 12 man hours, while another required 37 hours for the same job (Table I.) One required 12 man hours to grade and pack 10,000 stalks, while another used 28 hours. It took one organization 4 times as much manpower as another to handle empty boxes.

Similar comparisons were made for every operation in the entire process of harvesting and packing celery. No one organization was particularly efficient in every operation. Certain operations required considerable time in all organizations. Motion analyses were made of such jobs. The details of the study were then combined into tables and taken back to each of the organizations. While conferring with one organization, the identity of the others was not revealed. Where one organization was high in the use of labor compared with the others, the reasons were discussed. Some organizations requested more detailed study of their particular problems. Nearly every organization was able to bring about some improvement in its use of labor. One organization which had about the most efficient operation in the study was able to increase its over-all output 41 percent the first week the results of the study were released to it. Not all this increase was a result of the study, although a large part of it was attributed directly to it. Harvesting costs were materially lowered. The increased output was largely the result of one motion analysis, although there were also changes in the crew organization, the method by which strippers were working, and advanced planning by foremen. Also of importance was the realization on the part of management that the organization was not already doing a perfect job. This organization was interested in knowing how it compared with the others, but its increased output was mostly the result of a careful review of what it was doing and of the use of motion analyses to find how it could do various jobs easier and faster.

The celery study had some interesting "by-products." One such product was a method of holding celery in the field crate by means of a wooden strap. Another was a little different style of field crate built to reduce loss through breakage. The crate is cheap to construct, stacks better than the crate commonly used, and is less complicated to make. There is interest in a mechanical celery harvesting machine. Several are now being built in the State. It is entirely feasible to cut, top, and load celery mechanically, thereby greatly reducing the 160 hours of man labor per acre now required for the job. The celery study is by no means complete. There are many operations that need study now and, as technological progress institutes changes, further studies will be needed.

A check-list of questions is commonly used before detailed motion analysis is made. Frequently the questions are all that is needed to find a simplified method.

1. Can the job or part of the job be left out? Why does it have to be done?
2. Is there an easier way to do the job?
3. Can two operations be combined and accomplished simultaneously?
4. Will changing the order of the work reduce labor requirements?
5. Can machinery or tools be adapted to the job?
6. Where one hand is used, can a job be found for the other one?
7. Is there a way of paying labor an incentive wage?
8. Is labor skillfully supervised and properly trained when a new job is undertaken?

Through the use of this check list and motion analyses, it has been possible to reduce the amount of labor required for harvesting celery by some organizations. With some adaptation, similar methods should get results used with other crops.

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Table I. —Man Hours Required to Handle 10,000 Stalks of Celery for Selected Operations by 9 Florida Organizations, 1944

<table>
<thead>
<tr>
<th>Organization</th>
<th>Cut and strip</th>
<th>Grade and pack</th>
<th>Handle empty crates in field</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>26</td>
<td>21</td>
<td>4.1</td>
</tr>
<tr>
<td>B</td>
<td>17</td>
<td>21</td>
<td>1.5</td>
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<tr>
<td>C</td>
<td>22</td>
<td>23</td>
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<tr>
<td>D</td>
<td>29</td>
<td>23</td>
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</tr>
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<tr>
<td>I</td>
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</tr>
</tbody>
</table>

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THE SIGNIFICANCE OF THE SOIL NITRATE TEST FOR CABBAGE

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The possibility of using soil tests as an aid in the control of fertility has considerable appeal to those interested in crop production. Information of practical value is obtained when tests are properly conducted and when supplementary information necessary to evaluate the data is available. It is the purpose of this paper to present data to show the correlation between the soil nitrate nitrogen test and cabbage growth, and to point out some of the factors which enter in to complicate the relationship.

Specific data with respect to cabbage production was obtained from the Hastings area in cooperation with Dr. A. N. McCubbin of the Hastings Laboratory of the Florida Agricultural Experiment Station. Supplementary information on the rate of soil nitrate nitrogen production was obtained from the Homestead area in cooperation with Dr. G. D. Ruehle of the Sub-Tropical Experiment Station.

It is thought that plants take in nitrogen predominantly in the forms of nitrate and ammonia. In the past it was assumed that all but a few plants used only the nitrate ammonia in significant quantities.