ABSTRACT OF THESIS

# Labor Requirements, Irrigated Crops 1947

# Labor Requirements for Producing Sugar Beets, Potatoes, Barley, and Beans Under Irrigation, Weld County, 1947

by

K.M. Shaw

# ABSTRACT

Although many farm management studies have been made by western Agricultural College Experiment Stations, not many have been made since recent mechanization has taken place in the farming industry. Mechanization is being made rapidly in the sugar beet industry especially, with the result that the machine is taking the place of hand labor more every year. To keep current with these several changes is the justification for the analysis of the field labor requirements of four common crops grown under irrigated conditions.

This is a portion of the study made by the Bureau of Agricultural Economics, United States Department of Agriculture, and by the Department of Economics, Colorado Agricultural and Mechanical College, in 1947.

The problems to be analyzed are as follows:

1. What are typical operations on each crop?

2. What crew and times over are commonly used?

3. What effect does previous crop have on time used in seedbed preparation?

4. What variation, if any, in hours spent on irrigating and effect upon yield?

5. What is the effect of substituting specific pieces of equipment upon hours per acre (based on specific studies)?

The first crop analyzed is the sugar beet crop with an average of 91.00 man hours and 12.44 tractor hours per acre of beets harvested.

By taking out the records of those farms on which horse drawn inplements were still being used, it was found that 88.34 man hours and 13.72 tractor hours were necessary to produce one acre of beets.

Efficiency of hand labor crews cannot be readily determined by statistical analysis, nor is possible to be controlled by the grower, so little time is being devoted in this paper to hand labor.

Only 52 percent of the growers applied manure, so one of the greatest variations in seedbed preparation resulted from whether manure was or was not applied. If the operation of manure spreading is omitted, then the average seedbed preparation time as given in

Table 2 becomes 4.44 man hours per acre.

Further, it was found that there were 0.14 man hours less necessary to prepare the seedbed when the determination was made by equation instead of the survey method.

Some time in seedbed preparation was saved by using a 2-bottom 16-inch plow instead of the smaller plows. Times over for the implements disk, spring-tooth harrow, spike tooth harrow, and float, determined the hours spent in seedbed preparation more than the variation in width of these implements determined labor inputs because seldom is the true width the effective width.

A considerable saving in time was made when 6-row drills and 6-row cultivators were used instead of the more common 4-row implements.

Not enough data was collected to make a positive statement as to the efficiency of mechanical blockers to cut down on the time used in blocking and thinning the beets.

Much saving of time was made by the use of tractor operated loaders as compared with the old hand loading method. Still further, man hours of labor are saved when the beet harvester is used. This

If weeds are controlled by cultivation, hand labor in weeding will not be necessary.

Time spent in irrigation and cultivation is determined more by the season than by any other factor.

A material saving of time has been made in dusting potatoes by use of the airplane instead of by tractor drawn duster, but as this work done by airplane is on a custom basis no accurate information was available for the writer to make positive conclusions on this substitution.

Potato harvesting calls for an outlay of man hours of labor nearly as great as that for sugar beets. Potato combines or harvesters are on the market, but because of mechanical imperfections are not in general use. However, in potato production as well as in beet production attempts are being made to increase the mechanical operations in order to reduce labor inputs.

The third crop to be studied is that of barley. Man hours to produce an acre of barley varied from a low of 6.83 man hours per acre to a high of 24.81 man hours per acre.

Seedbed preparation varied from a low of 1.39 man hours per acre to a high of 5.37 man hours per acre. None of the barley growers applied manure and only five

of the growers used a plow. The lowest figure reported for seedbed preparation was found when the producer went over the field once each with renovator, harrow, and float.

More variability was found in seedbed preparation due to variation in the number of operations performed rather than to variations in size of equipment.

In Category 2, size of drills accounted for some of the variability. By use of the 10-foot drill instead of a 7-foot drill 0.85 man hours per acre could be saved.

There was a wide variation in irrigating time, both between individual farms and between the two districts. The Eaton district reported 4.99 man hours used in irrigating an acre of barley, while in the Mead-Johnstown area only 2.09 hours per acre, on an average, were used.

No correlation was found in comparing yields with the number of times irrigated.

Two farms reported using combines and their harvesting requirements were very low compared to those growers using custom operated threshing equipment.

In binding the barley, the 10-foot binder showed a saving of 0.67 man hours per acre.

Shocking time varied widely due to the human element involved.

There was not great variability found in the threshing operations if we exclude those that combined. The low was 3 man hours per acre, and the high 8 man hours per acre. Machine inputs varied with the proportion of trucks or tractors used in getting the bundles of grain to the separator.

Other harvesting costs are proportional to the yields of grain produced.

The fourth crop studied was the bean crop. An acre of beans takes approximately twice as many man hours of labor as does an acre of barley.

The average number of man hours used to produce an acre of beans ranged from a low of 20.47 to a high of 69.89 man hours per acre, the average being 34.08 man hours.

A wide variation also existed in the use of equipment.

Seedbed preparation varied from a low of 2.28 man hours per acre to a high of 10.85 man hours. Some growers plowed while others used a spring-tooth harrow or renovator in varying combinations.

The largest variation in bean production

occurred in Category 2. Some growers found it necessary to weed the beans by hand and others did not. This caused the greatest variation.

Thirty-seven percent of the man labor inputs occurred in the harvesting category. Two of the bean growers used a combine to harvest and the others used custom threshing with bean huller. In the operation of combining, 4.16 man hours per acre were expended as compared to an average of 14.24 hours per acre when threshing by custom huller.

Other savings were made by using a 4-row cutter instead of a 2-row cutter. The advantage was 0.27 man hours per acre in the favor of the 4-row cutter.

Variation in threshing time was due to the wide variation in threshing crews and the type of equipment used by them.

It is possible to save 10.35 man hours per acre in bean production by use of 4-row cutters and by substituting the combine for threshing equipment.

In the Summary, inputs of man and equipment hours by categories are compared for all four crops.

Specific operations common to the several crops are compared by using the survey method and the Burdick equation.

# THESIS

# LABOR REQUIREMENTS, IRRIGATED CROPS 1947

# LABOR REQUIREMENTS FOR PRODUCING SUGAR BEETS, POTATOES, BARLEY, AND BEANS UNDER IRRIGATION,

# WELD COUNTY, 1947

T H E S I S

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# LABOR REQUIREMENTS, IRRIGATED CROPS 1947

# LABOR REQUIREMENTS FOR PRODUCING SUGAR BEETS, POTATOES, BARLEY, AND BEANS UNDER IRRIGATION, WELD COUNTY, 1947

Submitted by

Kenneth McKendree Shaw

In partial fulfillment of the requirements
for the Degree of Master of Science in Economics

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COLORADO AGRICULTURAL AND MECHANICAL COLLEGE



JUNE 11 1948

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY KENNETH McKENDREE SHAW

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R T Burdick
In Charge of Thesis

APPROVED R T Burdick
Head of Department

Examination Satisfactory

Committee on Final Examination

Dale L. Pomine

R T Burdick

C Richard Creek

J J Paschal

David A Wilson
Dean of the Graduate School

Permission to publish this thesis or any part of it must be obtained from the Dean of the Graduate School.

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# Chapter I

## INTRODUCTION

The problem to be studied in this case is to determine present-day inputs of man and tractor hours of labor necessary to produce four common crops under irrigated conditions. The emphasis in this analysis will be upon specific field operations in the production of sugar beets, potatoes, beans, and barley.

Source of material.--This is only a part of the study undertaken by the Colorado Agricultural Experiment Station, the Beet Sugar Development Foundation, and the Bureau of Agricultural Economics, U. S. D. A., cooperating which started in 1947.

The area studied was in two established farming communities in Weld County, Colorado. Economic studies were made on 86 farms--located, 39 in the Eaton District eight miles north of Greeley, the county seat, and 47 in the Mead-Johnstown area, southwest of Greeley. Only 77 of these farms grew sugar beets in 1947.

Finding the labor and material requirements for

producing sugar beets under modern mechanized conditions was one of the aims of the survey, but much data were also obtained on producing other crops common to the established rotations. The application of fertilizers and the feeding of livestock also entered into the determinations.

Review of previous work.--Many farm management studies have been made in other years and at most of the land-grant colleges. New York, Ohio, and Kentucky stations have produced a great amount of farm labor and machinery efficiency studies but these states do not report on irrigated crop requirements.

The western colleges of agriculture have not produced the volume of work that has been turned out by eastern schools, but some very good bulletins have been published. Montana, in cooperation with Mr. P. L. Slagsvold of the Department of Agricultural Economics, put out an exceptionally good bulletin (No. 338) in 1937, entitled, "Production Requirements and Costs on Irrigated Farms in Montana." Efficiency of farm machinery was emphasized, but it was horse-drawn for the most part.

Utah Agricultural College at Logan has published some very good bulletins, but water requirements and costs were more often stressed than labor and machinery efficiency. Earnest M. Morrison of the Utah

Experiment Station conducted a survey of the sugar beet industry and published his findings in 1945. The bulletin is known as No. 329 and is the latest in Utah. Costs per acre and costs per ton of beets produced were determined under Utah conditions. Farms average smaller in Utah than in Colorado and beet acreage only averaged 10 acres per farm. Such small farms do not easily lend themselves to the use of expensive mechanical equipment.

At the Colorado Agricultural Experiment Station several good bulletins have been published dealing with some of the problems to be found in producing crops under irrigated conditions. Pingrey and Burdick published Bulletin No. 353, September, 1929, dealing with costs in general. Then in June, 1939, Dr. R. T. Burdick published Bulletin No. 453 entitled, "Economics of Sugar Beet Production in Colorado." It was the culmination of ten years of intensive study of sugar beet production and at the time of publication was the most complete study of sugar beet costs that had been made. The efficiency of machinery was studied, but it was still largely horse-drawn machinery. Tractor-drawn machinery did not come into general farm use until the advent of the all-purpose tractor. This was near the close of the ten-year period.

The University of Nebraska College of Agriculture

published in 1942 Bulletin No. 341 entitled, "Sugar Beet Costs and Management on Irrigated Sections of Western Nebraska," and this is one of the latest bulletins available on sugar beet costs. The authors, George H. Lambrect and Walter L. Ruden, went into the cost of producing sugar beets quite thoroughly on a cost-per-ton basis. Schedules of 286 farms were taken, but it was still found that horses were quite generally used and the cost of horses was about 9 percent of the cost of the field operations, excluding the hand labor, as compared with 13.5 percent for the tractors.

In Technical Bulletin No. 36, written by Dr. R. T. Burdick, emphasis is placed upon methods for estimating labor requirements for both tractor and horse drawn implements. "Two lines of approach should prove helpful in answering this question: The first, to analyze published data, and the second, to calculate probable field labor requirements and compare the results with actual records." (1:18)

Description of Colorado area.--The purpose of the present Colorado study has been to secure an up-to-date analysis of the economics of sugar beet production, taking into consideration the increased mechanization found on farms in the surveyed area in the crop year 1947.

The study was confined as nearly as possible to two distinct soil types, both of high productivity but of unlike water supply. In the Eaton District, Weld loam is the predominating soil type, while in the Mead-Johnstown area Weld clay loam is the predominating soil type. Of the two soil types, the Weld clay loam is a little more difficult to work, has a higher water holding capacity, and the water requirement is consequently lower. It might be assumed that the hours required for irrigation would be greater in the Eaton area while the hours for seedbed preparation would be greater in the Mead-Johnstown area.

The sample is approximately 3.5 percent of the total number of farms in Weld County and covers approximately 5 percent of the sugar beet acreage in Weld County, (based upon 1944 census figures).

As sugar beets are one of the principal cash crops, constituting 20.8 percent of the irrigated acreage of the farms studied in the Eaton area and 18.2 percent of the acreage in the Mead-Johnstown area, more space will be given to the labor inputs on the sugar beet crop than on the other three.

Four classifications as to size of farms studied were made in the tabulation work.

Table 1.--CLASSIFICATION OF FARMS STUDIED

| Size of farms | Number of farms | |
|---|---|---|
| | Eaton area | Mead-Johnstown area |
| 0 - 120 acres | 3 | 6 |
| 121 - 155 acres | 18 | 13 |
| 156 - 215 acres | 11 | 12 |
| 216 + acres | 3 | 11 |
| TOTAL | 35 | 42 |

The average size of farms in the Eaton district was 163 acres, and 196.8 acres in the Mead-Johnstown district.

The problems to be analyzed in this paper are as follows:

1. What are typical operations on each crop?

2. What crew and times over are commonly used?

3. What effect does previous crop have on time used in seedbed preparation?

4. What variation, if any, in hours spent on irrigating and effect upon yield?

5. What is the effect of substituting specific pieces of equipment upon

hours per acre (based on specific studies)?

The problems as defined will be discussed in the next four chapters:

Chapter II—Field Labor Requirements for Sugar Beets;

Chapter III—Field Labor Requirements for Potatoes:

Chapter IV—Field Labor Requirements for Barley;

Chapter V—Field Labor Requirements for Beans.

The Burdick equation used in the comparative analysis in these chapters is as follows:

$$T = \frac{8.25}{SW}\left(1 + \frac{16\,SN}{3\,L}\right)(1 + A).$$

"In this equation T is the crew hours per acre per operation for once over. S is the speed of travel in miles per hour; W is the effective width of the machine in feet; L is the length of the field in rods; N is the time required for turns at the end of the field expressed in fractions of a minute; and A is an overall service and rest allowance expressed as a decimal." (1:3)

# Chapter II

## FIELD LABOR REQUIREMENTS FOR SUGAR BEETS

Detailed studies were made of the cropping practices on 57 of the 77 farms growing sugar beets. Because of incomplete information two of these records have been discarded, but Farm E-24 had three separate fields in which there was a distinct variability in the manner of preparing and caring for the crop and has been treated as three farms. The averages have been calculated on the basis of 57 detailed records. (One record carried through the planting process and then was dropped because of abandonment of crop.) At least three visits were made by investigating personnel to each farm: one during or immediately following the planting season, one during the growing season, and one at the end of the harvest season.

An over-all picture of the results of this detailed survey shows the following:

Table 2.--LABOR AND EQUIPMENT INPUTS BY CATEGORIES FOR ALL FARMS, HOURS PER ACRE

| Categories | Man hours | Tractor hours | Truck hours |
|---|---|---|---|
| 1 - Fertilizing and seedbed preparation | 7.32 | 5.35 | 0.17 |
| 2 - Planting and cultural | 46.56 | 3.73 | 0.01 |
| 3 - Harvesting operations | 37.12 | 3.36 | 6.29 |
| TOTAL | 91.00 | 12.44 | 6.47 |

Expressed in percentages, we find that:

Category 1 called for 8 percent of the man hours and 43 percent of the tractor hours;

Category 2 called forth an expenditure of 51 percent of the man hours and 30 percent of the tractor time;

Category 3 called for 41 percent of the man hours and only 27 percent of the tractor hours.

Since 19 of the 57 farms, or 33 percent, still used horses to some extent in beet production, the above picture is not exactly a true comparison since it shows actual man hours for all farms but does not show the horse hours.

By taking out the records of those farms on which horse drawn implements were still being used, the following averages were found for the all-tractor implement farms:

Table 3.--INPUTS BY CATEGORIES—ALL IMPLEMENTS TRACTOR DRAWN

| Categories | Man hours | Tractor hours | Truck hours |
|---|---|---|---|
| 1 | 5.94 | 5.79 | 0.14 |
| 2 | 46.79 | 4.54 | 0.01 |
| 3 | 35.61 | 3.39 | 6.30 |
| TOTAL | 88.34 | 13.72 | 6.45 |

This last average, by categories, will be used in comparing the different methods of procedure where considerable variability occurs.

The average yield per acre of sugar beets was high in 1947. Based on Great Western Sugar Company records, the average yield for the farms studied in the Eaton district was 19.21 tons per acre and in the Mead-Johnstown area 19.47 tons per acre. Only 5 farms showed a yield lower than 15 tons per acre, while 16 farms in the Eaton district and 14 in the Mead-Johnstown area showed yields above 19 tons per acre.

Normally, the Mead-Johnstown area is short on late water, which is so necessary for high beet yields, but that was not the case in the year 1947. There is not enough difference in yields to show that increased inputs of labor and equipment in one area resulted in higher yields, but it will be possible to show that variability in management resulted in lower time requirements in many instances. These are worth taking note of.

Hours of labor to produce an acre of beets varied from a low of 62.54 hours per acre to a high of 142.72 hours per acre.

It can readily be seen that there is considerable variation in the inputs of man hours per acre. Much of this can be accounted for by the fact that the hand labor used in the thinning, hoeing, and hand topping work showed great variability. Many of the contract labor crews were new at the work and consequently inefficient. Especially during the time for blocking and thinning, the weather was rainy and crews put in only partial time. The farmers had difficulty in measuring the actual time spent, and then, too, it was longer than usual due to unfavorable weather conditions. It is the writer's opinion that the time for hoeing and topping is much more accurate than that given for the thinning. As

these hand labor operations are paid for by the acre rather than by the day, the farmer does not have much control to affect the variability in length of time to do these contract labor operations. Little time will be devoted to variability in contract labor time other than to give one size of crews and upper and lower limits.

Some variability existed in the time for irrigating, the lower limit being 1.55 and the upper limit 20.57 hours. The average is 8.05, which will compare with that of 9 hours as found at the Nebraska Experiment Station on the first grade land.

Variability in hours to do specific operations with implements in the several cultural and harvesting operations necessary to produce an acre of beets is due to several factors, and it is the purpose of this paper to study these in particular with recommendations for those improved practices that show merit.

It is possible to perform 20 different operations in the production of beets, each of which might vary in the number of hours necessary to perform it depending on the number of times performed, type and size of implements used, length of field, and distance to market. It is felt that the choice of surveyed area eliminated as far as possible any large variation due to strictly soil conditions.

The very first operation in considering growing an acre of beets is the application of barnyard manure. Seventy-eight out of the 86 farms reported livestock feeding as a general rule although several of these did not feed in 1946 and 1947. Manure was available on most of the farms but it was not always applied to the beet ground. In the Eaton district, in particular, it is customary to follow potatoes with beets and the manure is applied to the potato ground. Farmers are not in agreement as to the percent of benefit derived by the two crops, so the manuring operation will be studied from the viewpoint of those actually applying manure in the 1947 crop year.

As a preliminary study, let us inquire into the crop rotation practices of the two surveyed areas. The most popular rotation in the Eaton area is alfalfa, potatoes, beans, beets, and barley. Twenty-one of the 35 Eaton farmers reported as favoring this rotation. In all cases but two, beets followed a cultivated crop, usually potatoes or beans; only two reported beets following grain stubble.

In the Mead-Johnstown area a rotation of alfalfa, corn or peas, beets, and small grain was the most popular rotation; 12 of the 42 farms reporting favored this

although 10 held to a rotation of alfalfa, beets, and small grain. On the 23 farms on which detailed records are available, it was found that beets followed grain stubble in 12 cases, alfalfa stubble in one instance, while the rest followed cultivated crops. Of these latter-mentioned, beets followed peas in 5 instances, and beets in 3, with the other 5 reporting some combination of corn, potatoes, or fallow. It is not customary to follow beets with beets a second straight year, but the beets that were grown a second time followed an abandoned beet crop the year before. The year 1946 was unfavorable to beet production in the Mead-Johnstown area for two reasons: a shortage of late water caused some to be abandoned, while an unseasonal snowstorm prevented the harvest of an appreciable acreage.

Twenty-nine of the 57 fields on which detailed records are available reported a manure spreading operation in 1947. The time to accomplish this on one acre varied widely because of the many combinations of equipment used to do the work. The lowest time reported was 3 man hours and the highest 25.60 man hours per acre, with an average of 6.08 man hours for all methods.

By far the most common method was the use of a crew of 3 men and 3 tractors, one of the tractors equipped

with hydraulic loader and the other two drawing spreaders.

Two farms used the old hand-loaded horse drawn spreaders. Their labor requirements were high.

Eight farms used tractor powered loaders but used horse drawn spreaders for the most part.

There were many ways of spreading manure but Table 4 selects three categories as being most representative.

Table 4.--MANURE APPLICATION

| Number of farms reporting | With tractor drawn equipment | | With horse drawn equipment and hand loaders | | Loaded by tractor equipment spread with horses | | |
|---|---|---|---|---|---|---|---|
| | Man hours | Tractor hours | Man hours | Horse hours | Man hours | Tractor hours | Horse hours |
| 19 | 4.73 | 4.25 | | | | | |
| 2 | | | 18.49 | 22.71 | | | |
| 8 | | | | | 6.63 | 3.21 | 6.49 |

In the Mead-Johnstown area manure was applied in the fall and disked or plowed under, while in the Eaton area the common method was to spread and plow under in the spring.

Following the manure application, the various operations in seedbed preparation will be taken and analyzed in order.

Picture 1.--Manure loading, tractor loader

Picture 2.--Beets growing on William Wolf farm

Combinations of operations and single times over for the more important will be compared.

Forty-one of the farms reported plowing, using four different widths of plows

Table 5.--TIME FOR PLOWING ONE ACRE

| | Width of plow | | | |
|---|---|---|---|---|
| | 16-inch | 18-inch | 28-inch | 32-inch |
| Average time | 1.57 | 1.90 | 1.40 | 1.29 |
| Number reporting | 7 | 5 | 17 | 12 |

The average tractor speed for those pulling two 14-inch plows was 3.50 miles per hour. The average length of field was approximately 60 rods.

By using the equation for field crop analysis developed by Dr. Burdick of the Colorado A & M College in which one-half minute was allowed for turns and 0.35 as the "A" factor (giving consideration to rest and service), it is found that the plowing with 2-bottom 14-inch plows should take 1.56 hours per acre.

In the case of the 32-inch (two 16-inch plows), the average speed per hour was 3.40 miles and the length 70 rods. By using the constant terms mentioned in the above equation, the plowing of one acre should have been accomplished in 1.37 hours.

In the case of the 18-inch plow, the average speed was 3.75 miles per hour and the average length of the field 40 rods. By the Burdick equation, using the constants already mentioned, the time should have been 2.21 hours per acre.

In the case of the 1-bottom 16-inch plow, the average speed was 3.90 miles per hour and the average length of the field 60 rods. By the use of the equation, the time should have been 2.47 hours per acre.

Five farms are reported as having used a spring-tooth harrow instead of plowing. These implements varied in width from 6 to 12 feet but the 8-foot width was most commonly used. The average time to go over an acre of ground was 0.68 hours, but fully as many farmers went over the ground twice as did those only going over the ground once so that the advantage was not so great in favor of the spring-tooth if one considers time alone. A study of the gasoline requirements of the two operations, plowing versus spring-toothing, might have shown a greater advantage in favor of the spring-tooth harrow.

In comparing the time of doing this operation as reported by the survey with that shown by the Burdick equation, we find that it should take 0.52 hours per acre once over to do this operation where the average speed

was 3.25 miles per hour and the average length of field was 50 rods.

In addition to the five farmers reporting substituting spring-tooth harrowing for plowing, eight others reported using the spring-tooth in combination with plowing or disking.

Six of the 57 farms reporting showed a renovator being used instead of a plow, and nine others showed the renovator being used in combination with other implements.

The most popular width of renovator was found to be 6 feet, and the average time to go over an acre was 1.68 hours per acre, which is 0.11 hours per acre more than required by a single-bottom 16-inch plow but 0.38 less than required for a 2-bottom 14-inch plow.

Allowing for an average speed of 3.0 miles per hour and with a length of 60 rods to the field, the equation shows that this time could have been performed once over in 0.70 hours.

Twenty-nine of the 57 farms reported using an 8-foot tandem disk in the preparation of beet ground. Eleven did this after spreading manure and before fall plowing. The average time spent on one acre in seedbed preparation is found to be 0.88 and for one operation 0.52 hours.

By using the equation, we find that where the average tractor speed was 3.87 miles per hour and the average length of field was 75 rods, the hours per acre to do a single disking operation should be 0.42 hours.

Typically, farms using the tandem disk used it only once, but there were cases where the disk was drawn over the field 3 and 5 times.

All farms studied but two showed a harrowing operation but the "times over" varied from 1 to 9 with the average being 3. The most popular width was 15 feet, as 35 gave this width, with others widely scattered.

The average length of field was 60 rods. This seems short compared to the other average lengths of fields, but it must be remembered that many farms harrow across the short length of the field as well as the long way.

An average of the 55 farms indicates that 1.11 hours of harrowing per acre per farm was accomplished in the seedbed preparation for beets. If we take away the 7 farms that used horses in this operation, we have an average for the 48 farms of 0.88 hours per acre which for one time over for the typical is equal to 0.29 hours per single time over the acre of ground.

In using the Burdick equation for the average

tractor speed of 3.75 miles per hour and an average length of field of 60 rods, we find that the work could have been done in 0.24 hours per acre.

Twelve farms reported using a roller, drawn by tractor except in three cases. The average time for rolling with tractor was 0.70 hours per acre.

Three farms reported using a tiller packer, but it was not a common practice. The average time for the three was 0.38 hours per operation.

The operation of floating or leveling was performed by a variety of sizes and weights of implements on all the farms, but on 4 horses furnished the motive power. An average of the 43 farms in which tractors were used showed that it took 0.91 hours per acre to perform the floating operation.

Times over varied from 1 to 5 times with 2 times over being the most common, and 12-foot the popular width. For the tractor drawn floats an average of 0.42 hours per acre was the time for a single operation.

By the use of the equation, this time should have been 0.27 hours per acre where the average speed of tractor and length of field were 3.75 miles per hour and 60 rods, respectively.

Table 6 gives a typical farm showing the respective hours per acre for the successive operations.

Table 6.--LABOR REQUIREMENTS EXCEPT FOR HARVESTING SUGAR BEETS—TYPICAL CASE, HOURS PER ACRE

| Operation | Width in feet | Times over | Over once | | For season | | |
|---|---|---|---|---|---|---|---|
| | | | Man hours | Tractor hours | Man hours | Tractor hours | Truck hours |
| Spreading manure[1] | - | 1 | 4.73 | 4.25 | 4.73 | 4.25 | 0.17 |
| Disking | 8 | 1 | 0.52 | 0.52 | 0.52 | 0.52 | - |
| Plowing | 2.33 | 1 | 1.40 | 1.40 | 1.40 | 1.40 | - |
| Harrowing | 15 | 3 | 0.29 | 0.29 | 0.87 | 0.87 | - |
| Floating | 12 | 2 | 0.42 | 0.42 | 0.84 | 0.84 | - |
| Planting | 7.33 | 1 | 0.94 | 0.89 | 0.94 | 0.89 | 0.01 |
| Cultivating | 7.33 | 3 | 0.87 | 0.87 | 2.61 | 2.61 | - |
| Ditching | 7.33 | 2 | 0.87 | 0.87 | 1.74 | 1.74 | - |
| Thinning and blocking | - | 1 | 21.14 | - | 21.14 | - | - |
| Hoeing | - | 2 | 6.19 | - | 12.38 | - | - |
| Irrigating | - | 5 | 1.67 | - | 8.35 | - | - |
| TOTAL | | | | | 55.52 | 13.13 | 0.18 |

[1] 3-man crew, 3 tractors, 1 loader, 2 spreaders

In planting the sugar beet seed (segmented) two widths of drills are common: 4-row 22-inch drills and 6-row 20-inch drills. There were two drills of 132-inch width, but the class was not large enough to give special significance. Nine of the 88-inch drills were horse drawn.

The average time to plant one acre with the tractor drawn 88-inch drill was found by survey to be 0.94 hours. The average time to plant one acre with the 120-inch drill was 0.51 hours. It is seen that a saving of 0.43 hours could be made by using the 6-row drill in place of the more common 4-row drill.

The average for the nine farms still using the 88-inch drill, horse drawn, was 0.95 hours per acre, there being little to choose between tractor drawn and horse drawn equipment in this operation. Planting is customarily done at slow speed even where a tractor is used.

Table 7.--LABOR REQUIREMENTS FOR DRILLS, HOURS PER ACRE

| Number farms using drill | Time with 88-inch tractor drawn drill | Time with 88-inch horse drawn drill | Time with 120-inch tractor drawn drill |
|---|---|---|---|
| 34 | 0.94 | | |
| 9 | | 0.95 | |
| 14 | | | 0.51 |

On two of the farms using 88-inch drills, a 2-man crew was used in the drilling. This results in a slightly lower average for the tractor time, it being 0.89 hours per acre while the man hours were 0.94.

In the cultivating operation, the same widths of cultivators were used as were employed in the drilling. If the 88-inch 4-row drill was used, the 88-inch cultivator was also used.

Thirty-one farms used 88-inch tractor drawn cultivators and 14 used 120-inch cultivators. The remainder used horse drawn implements. Tractor speeds varied all the way from 1.66 miles per hour to 7.75 miles per hour. The average length of row was found to be 70 rods.

By survey it was found that the 88-inch tractor drawn implements took 0.87 hours to go over the acre one time; the 6-row cultivators took 0.57; and the horse drawn cultivators 0.78 hours per acre. The 6-row shows a saving over the 4-row cultivator of 0.30 hours per acre in one operation.

By using the Burdick equation, in which the average tractor speed was 3.36 miles per hour and the average length of field 70 rods, the 4-row cultivator should take 0.52 hours per acre and the 6-row cultivator

with an average tractor speed of 3.0 miles per hour should do the same amount of work in 0.42 hours.

Farms varied somewhat in the number of times to go over a field with a cultivator during the crop year. This variation ranged from 2 to 6 times, with the average being a little over 3.

Table 8.--TOTAL CULTIVATING TIME PER ACRE FOR SUGAR BEETS

| Number farms using cultivator | 4-row tractor drawn cultivator | 6-row tractor drawn cultivator | 4-row horse drawn cultivator |
|---|---|---|---|
| 31 | 2.62 | | |
| 14 | | 2.05 | |
| 11 | | | 3.33 |

It is regrettable that a larger number using the 6-row cultivator was not available to make the above table more significant.

Two farmers in the Mead-Johnstown area used a finger weeder (width, 12 feet) which took on the average 0.78 hours per acre to cover once. This took the place of one to two cultivations and would result in a saving of 0.09 hours per acre over a 4-row cultivator.

The ditching operation is very similar to the cultivating, the same widths prevailing, the only difference being in the width and spacing of tools employed.

By survey, it was found that the 4-row tractor drawn implement took 0.87 hours per acre once over while the 6-row implement took 0.65 hours per acre. The 4-row horse drawn implement took 0.94 hours per acre.

The average number of times for ditching was 2, so the total time for ditching was 1.74 hours in the case of the 4-row tractor drawn, 1.30 hours with the 6-row tractor drawn, and 1.88 hours with the horse drawn ditcher.

A number of farmers combined one ditching with the last cultivating, which resulted in the saving of at least 0.87 hours in the case of the 4-row implement.

Irrigating time varied also with the spread between the number of times water was applied to the beet crop varying from 2 to 10 times. The average was 3 times in the Mead-Johnstown area and 6 times in the Eaton area. The amount of time actually spent with the water also varied considerably. The lowest time per acre reported for the crop season was 1.17 hours, and the highest was 20.57 hours, with the average being 8.25 hours per acre for the 56 farms on which detailed information was available. Nebraska Bulletin No. 341 gives 9 hours as the average time spent in irrigating on the best grade of land.

When the beet plants have 3 to 4 leaves, they are thinned to 12 to 14 inches apart in the row. This is customarily accomplished by hand labor working on a flat rate per acre basis. All growers for the Great Western Sugar Company were furnished segmented seed in 1947, which gives a stand that is more easily thinned than does the unprocessed seed. While the work should have taken less time, due to the planting of processed seed, many growers reported difficulties with inexperienced help. There were a number of days in which crews could not work full time due to weather conditions in the spring of 1947. The average time for blocking and thinning beets on 56 farms surveyed is computed to be 21.14 hours per acre and does not disagree greatly with previous survey information.

The average sized crew for the blocking and thinning was found to be 5 to 6. The work was customarily done on a contract basis, but there were a few instances where the farmer's own family did some or all of the work.

After the beets have been cultivated and irrigated, hand labor is again used to hoe out any weeds that may have been missed by the cultivator. Customarily a second hoeing is practiced about a month later, but because of the shortage of help in 1947 this was not done

on all farms. The average time spent was 12.37 hours per acre.

In only 2 instances out of the 86 farms surveyed were cross blockers used to assist in the thinning operation. In both of these cases the mechanical blocker was not looked upon with favor and was discontinued before the entire acreage was worked. Mr. Harry Sitler of the United States Bureau of Agricultural Economics conducted a separate study outside of the surveyed area and his findings, based on 19 cases, indicated that mechanical blocking could save as much as half the time of thinning if conditions for use were favorable. A speed of 2 acres per hour was attained by mechanical blocking machines.

One of the greatest variables was the labor in harvesting. This ranged from a low of 15.63 man hours per acre where a beet harvester was used to 54.02 man hours per acre where beets were pulled with horses and topped by hand labor.

The sugar beet harvester is just beginning to be used in Weld County. Of the 57 farms on which detailed records were available, 3 harvested the entire crop with beet harvesters and 6 others harvested a part of the crop with harvesters. Some wet weather late in

the harvesting season made for slow progress in both hand topped and machine harvested beets. Where weather conditions were favorable, the beet harvester has proved very successful. In the surveyed area, 15.8 percent of the beet acreage was topped by mechanical harvesters in 1947.

While the use of the beet harvester increases tractor time somewhat, the hand topping is eliminated and this is an important item of labor input. The average hours per acre for hand topping of beets was found to be 28.66.

Six of the 57 farms still pulled beets with horse drawn pullers. Seven of the farms reported beets loaded by hand. Forty farms reported topping by hand and then loading by mechanical loaders. Seventy-seven percent were thus loaded.

Beets pulled by tractor were customarily pulled by a puller taking 2 rows at a time, but it was found that 14 producers were still using 1-row pullers.

It was impossible to separate the operations of pulling and clearing pile row in some cases, so these were left out of the comparison of 1- and 2-row pullers.

An average of 7 farms using 1-row pullers was

found to be 2.39 hours per acre, while an average of 31 farms using 2-row pullers was found to be 1.49 hours per acre. This gives the 2-row puller an advantage of 0.90 man hours per acre.

The average tractor speed for the 1-row puller was calculated to be 3.30 miles per hour, and for the 2-row puller 2.26 miles per hour. The average length of row for all beets was 70 rods.

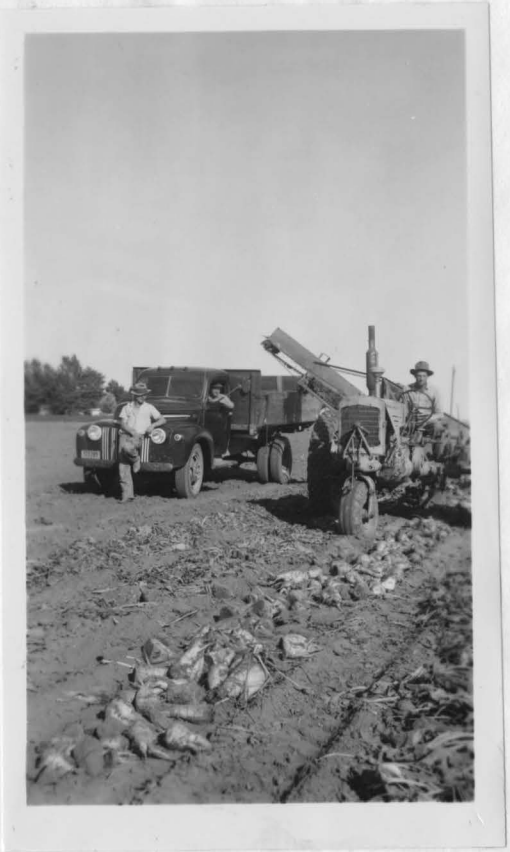
By using the Burdick labor analysis equation as in previous comparisons, it is found that the work could have been done in the case of the 1-row puller in 2.08 hours per acre and in the case of the 2-row puller in 1.05 hours per acre.

There were 33 instances in which it was possible to keep the "A"-ing out operation separate from other harvesting operations. An average of these 33 so reporting shows an average of 0.53 hours per acre for this operation.

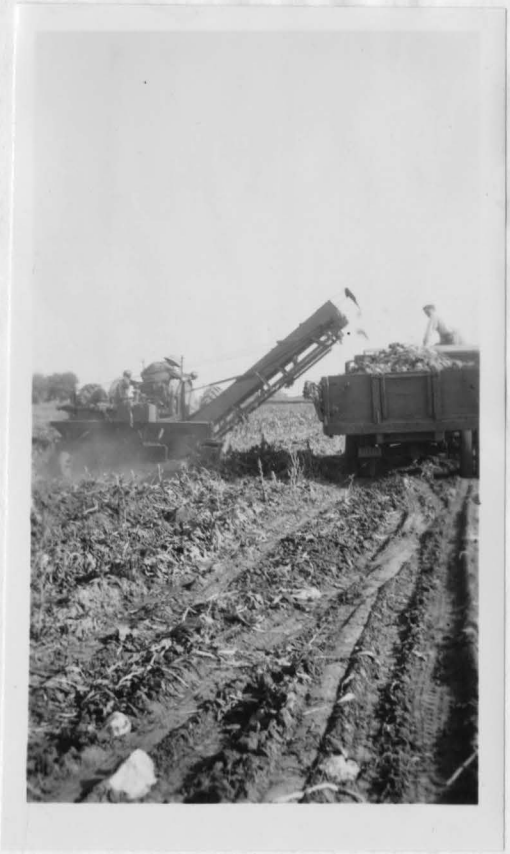
The following table shows a comparison of hand loading and mechanical loading.

Table 9.--COMPARISON OF HAND LOADING WITH MECHANICAL

| | Man hours | Tractor hours |
|---|---|---|
| Loaded by hand | 8.85 | -- |
| Loaded by mechanical loader | 1.29 | 1.29 |



Picture 3.--Beets loaded with mechanical loader



Picture 4.--Keist 2-row sugar beet harvester

There was also considerable variability in hauling time, which was to be expected as trucks varied in size and distances to dumps were greater than others in many cases. Usually there was 1 man to a crew, but occasionally 2 men.

An average of 40 farms showed 5.83 man hours and 5.71 truck hours per acre. The variation was from a low of 1.36 hours per acre to a high of 14.0 hours per acre.

The 3 farms using mechanical harvesters reported an average of 17.85 man hours per acre and 5.35 tractor hours per acre in the harvesting operation. No time was required for hand topping.

Table 10 gives a comparison of the four methods used in harvesting.

Table 10.--COMPARISON OF METHODS USED IN HARVESTING SUGAR BEETS, HOURS PER ACRE

| Method used | Number farms | Field labor | Hand top | Total man hours | Tractor hours | Truck hours | Horse hours |
|---|---|---|---|---|---|---|---|
| With horses | 6 | 13.37 | 29.39 | 42.76 | 0.34 | 6.42 | 11.09 |
| Load by hand | 7 | 17.10 | 30.44 | 47.54 | 2.84 | 8.92 | - |
| Load with mechanical loader | 40 | 9.19 | 28.23 | 37.42 | 3.49 | 5.69 | - |
| Harvesting with harvester | 3 | 17.91 | - | 17.91 | 4.79 | 8.98 | - |

Picture 5.--Scott-Urschall sugar beet harvester

A typical case of labor and truck hours of inputs per acre in producing beets is summed up in Table 11.

Table 11.--MAN HOURS PER ACRE BY CATEGORIES

| Categories | Truck hours | Man hours | | Tractor hours | |
|---|---|---|---|---|---|
| 1 - Seedbed preparation: | | | | | |
| Manure spreading | - | 4.73 | | 4.25 | |
| Disking | - | 0.52 | | 0.52 | |
| Plowing | - | 1.40 | | 1.40 | |
| Harrowing | - | 0.87 | | 0.87 | |
| Floating | - | 0.84 | 8.36 | 0.84 | 7.88 |
| 2 - Cultural practices: | | | | | |
| Planting | - | 0.94 | | 0.89 | |
| Cultivating | - | 2.61 | | 2.61 | |
| Ditching | - | 1.74 | | 1.74 | |
| Blocking and thinning | - | 21.14 | | - | |
| Hoeing | - | 12.37 | | - | |
| Irrigating | - | 8.25 | 47.05 | - | 5.24 |
| 3 - Harvest[1]: | | | | | |
| Pull and "A" | - | 2.02 | | 2.02 | |
| Hand top | - | 28.75 | | - | |
| Load | - | 1.29 | | 1.29 | |
| Haul | 5.71 | 5.83 | 37.89 | - | 3.31 |
| TOTAL | 5.71 | | 93.30 | | 16.43 |

[1]40 farms with tractor loader

This is 4.96 man hours and 3.99 tractor hours more than the averages in Table 3, but is due to the fact that a manure application was included and only 51 percent of the farms reported as applying manure in 1947.

By using 6-row planters and 6-row cultivators, beet producers could have saved 1.0 hour per acre.

By combining 1 ditching with the last cultivation, 0.87 hours per acre could have been saved.

By using mechanical harvesters, 29.51 man hours could have been saved.

Within the limitations of the small sample we can conclude that an acre of beets could be grown and harvested with an input of 56.96 man hours as compared to the average of 88.34 for farms using tractor equipment.

Size of farm had a direct bearing on the amount of labor inputs per acre. As the size increased labor inputs decreased, but tractor time increased. This is due principally to the fact that the larger farms were able to afford expensive mechanical harvesting equipment to take the place of hand labor.

Table 12.--INFLUENCE OF SIZE OF FARM ON LABOR INPUTS

| Size of farms | Number of farms | Man hours per acre | Tractor hours per acre | Truck hours per acre |
|---|---|---|---|---|
| 0-120 acres | 6 | 95.99 | 12.88 | 6.27 |
| 121-155 acres | 25 | 92.57 | 11.44 | 5.65 |
| 156-215 acres | 17 | 89.94 | 13.59 | 7.24 |
| 216 + acres | 8 | 84.46 | 12.95 | 7.63 |

# Chapter III

## FIELD LABOR REQUIREMENTS FOR POTATOES

Potato production was studied on 15 farms for which detailed records are available. Eleven of these farms are in the Eaton area, and 4 are in the Mead-Johnstown area.

The total acreage reported in potatoes in the surveyed areas was 682 acres, which represents 4.84 percent of the irrigated acreage. Only 51 acres were reported in the Johnstown area while the remaining 631 acres were reported in the Eaton area, which has long been noted for potato production. Detailed information was obtained on 51 acres in the Mead-Johnstown area and on 210 acres of potatoes in the Eaton area. The acreage per farm varied from 5 to 36, with the average being 17.

A summation of the inputs of labor and tractor time shows approximately 59 man hours and 15.25 tractor hours used to produce and harvest an acre of potatoes. The variation was from a low of 30.59 hours per acre to a high of 86.60 man hours per acre. Tractor time

varied from a low of 10.20 hours per acre to a high of 24.69 hours per acre.

There were 17 distinct operations in potato production on some farms, and in each of these there were some variations to be found--either in the time to perform a single operation or in the number of times certain operations were performed.

On 5 farms time was given to seed "cutting," but on the other 10 the seed was purchased or custom "cut." Because the time was not available on all farms, this operation will be omitted from the analysis. One farm was producing certified seed potatoes and a "roguing" operation required 1.11 hours per acre. This operation has also been omitted in order to compare those operations that were common to most farms.

The analysis of labor inputs will be broken down into three main categories: (1) seedbed preparation, (2) planting and cultural, and (3) harvesting.

Seedbed preparation will include application of manure and commercial fertilizer, plowing, renovating, spring toothing, disking, harrowing, and floating. The second category will include planting, ridging, cultivation, ditching, irrigation, and several methods of insect control. Eight of the farms also reported 1 to 2 harrowings

after planting, and this will be kept distinct from the harrowing used strictly for seedbed preparation. The third category will include all harvesting operations and hauling either to market or storage.

The following table gives an allotment of time, according to categories, in hours per acre.

Table 13.--FIELD LABOR REQUIREMENTS FOR POTATOES

| Categories | Average man hours | Percent of total | Average tractor hours | Percent of total |
|---|---|---|---|---|
| 1 - Seedbed preparation | 10.44 | 17 | 7.18 | 47 |
| 2 - Planting and cultural | 13.46 | 22 | 5.08 | 33 |
| 3 - Harvesting operations | 35.24 | 60 | 2.99 | 20 |

There was also an average of 5.97 hours per acre use of trucks, most of it being at harvest time but 0.88 hours per acre was utilized in hauling manure.

It can readily be seen from the table that the heavy outlay of man hours comes at harvesting time but that nearly one-half of the tractor hours are used in seedbed preparation.

Starting with the analysis of the first operation, manure application shows a variation ranging from

a low of 3.33 man hours per acre to a high of 22.50 man hours per acre.

Three of the 15 farms reporting did not show any hours for manure application. Five of those that did report also applied commercial fertilizer with manure.

Farm Number E-30 was high in man hours because the manure was forked into spreaders by hand. Farms E-39 and E-20 used some horses and trucks to get the job done. If we subtract the time that these farms reported from the total and only use an average for 9 farms applying manure with tractor powered loaders and spreaders, we compute an average of 5.67 man hours per acre and 3.71 tractor hours per acre to apply manure. This is probably as near a typical as can be found as there were no two of the nine applying manure that did it the same way. There was a variability of 1 to 5 in crew numbers and a variability of 1 to 5 tractors used.

Potatoes followed other crops as shown in the following table.

Table 14.--CROPS IN 1946 FOLLOWED BY POTATOES IN 1947

| Crop in 1946 | Number of farms reporting potatoes in 1947 |
|---|---|
| Alfalfa sod | 8 |
| Small grain | 2 |
| Corn | 2 |
| Beans | 1 |
| Peas | 1 |
| Uncertain | 1 |

All farms raising potatoes reported plowing as the next step after fertilizer applications, but there was considerable variation in the amount of time reported to do the job, ranging from a low of 1 hour per acre to a high of 3 hours per acre, the average being 1.74 hours per acre for the 15 farms.

Four different size plows were used (plowing done by custom, size uncertain, on one farm).

Table 15.--SIZE PLOWS USED--POTATO PRODUCTION--HOURS

| Number farms using | Time for 1 acre | | | |
|---|---|---|---|---|
| | 32-inch | 28-inch | 18-inch | 16-inch |
| 2 | 1.45 | | | |
| 6 | | 1.44 | | |
| 2 | | | 1.96 | |
| 4 | | | | 2.54 |

The average speed with which the plows were operated was as follows:

32-inch—3.60 miles per hour

28-inch—3.75 miles per hour

18-inch—3.00 miles per hour

16-inch—3.25 miles per hour

The average length of row was found to be 53 rods.

Using the Burdick equation with time for turns held constant at one-half minute and with 0.35 value for "A", we find the time should have been, if the total width had been the effective width, as follows:

| Width of plow | By equation | Actual |
|---|---|---|
| 32-inch | 1.41 hours | 1.45 hours |
| 28-inch | 1.52 hours | 1.44 hours |
| 18-inch | 2.65 hours | 1.96 hours |
| 16-inch | 2.99 hours | 2.54 hours |

It was also found that the time to plow alfalfa sod was greater than the time per acre to plow after the other crops. There was also a correlation in yields with the fields that were plowed from alfalfa giving higher yields than the average.

| Farm number | Plowing time per acre (hours) | Yield per acre (hundred weight) |
|---|---|---|
| E-2 | 2.89 | 173 |
| E-28 | 3.00 | 125 |
| E-29 | 1.59 | 150 |
| E-37 | 2.00 | 150 |
| E-72 | 1.36 | 182 |
| M-13 | 1.87 | 265 |
| M-52 | 1.40 | 130 |
| [1]M-58 | 1.00 | 348 |
| AVERAGE | 1.89 | 190 |

[1]Partly plowed from alfalfa stubble and part corn ground

Plowing time for fields that were in cultivated crop or grain stubble averaged 1.57 hours per acre for plowing and only yielded an average of 135 hundred weight of potatoes.

In addition to plowing, 10 of the farms reported using other tools to prepare the soil. Three farms used a renovator, two used a spring-tooth harrow, and five used a disk from 1 to 2 times.

The average for this type of preparation was 0.82 hours per acre. The tools varied widely in width and speed with which they were operated, but 7 feet was

probably the most common width used. The variations were so many that a typical operation was difficult to arrive at.

The average over-all time for harrowing was 0.44 hours per acre and that for floating 0.49 hours per acre. The most common width for harrows used was 15 feet and the most common width for floats 12 feet.

Times over for harrowing was 2 on the average, and 1 for floating.

The following table gives typical seedbed preparation time insofar as it was possible to determine from a 15-farm sample.

Table 16.--TYPICAL SEEDBED PREPARATION TIME, HOURS PER ACRE

| Operation | Implement width, feet | Times over | Crew | Man hours, 1 operation | For season's operations | |
|---|---|---|---|---|---|---|
| | | | | | Man hours | Tractor hours |
| Manure spreading | - | 1 | 3 | 5.67 | 5.67 | 3.71 |
| Plowing | 2 1/3 | 1 | 1 | 1.54 | 1.54 | 1.54 |
| Renovating or disking | 7 | 1 | 1 | 0.73 | 0.73 | 0.73 |
| Harrowing | 15 | 3 | 1 | 0.51 | 1.53 | 1.53 |
| Floating | 12 | 1 | 1 | 0.53 | 0.53 | 0.53 |
| TOTAL | | | | 8.98 | 10.00 | 8.04 |

In Category 2, the first operation is that of planting. Four farms reported using 2-row drills 34 inches between rows, and 11 used 2-row drills 36 inches between rows. Six were operated by crews of 1 each, 7 by crews of 2 each, and 2 drills were operated by 3-man crews. Time for this operation varied from 0.89 hours per acre to a high of 5.45 hours per acre.

There was little difference between 34-inch and 36-inch drills, but there was considerable difference when 1, 2, or 3 men were used in the crew.

| Farms reporting | Crew | Average time to plant 1 acre |
|---|---|---|
| 2 | 3 | 5.23 |
| 7 | 2 | 2.73 |
| 6 | 1 | 2.56 |

Planting speeds were quite similar to plowing speeds.

After planting, 9 farms reported 1 to 2 harrowings to break the crust. Average time for this operation was 0.44 hours per acre.

Six farms reported a "ridging" operation, but this was not typical. Average time for the 6 reporting was 0.79 hours per acre.

Two farms reported using a finger weeder and 3 others did some hand weeding.

Cultivations varied in number from 1 to 5, and time for 1 cultivation varied from 0.25 hours per acre to 1.12 hours per acre, the average being 1.43 hours per acre.

Ditching was included with the cultivating on 4 farms and the typical was 1 ditching at 1.15 hours per acre.

Irrigating time averaged 7.50 hours per acre, but the number of times ranged from 3 to 8. Typically, the Mead-Johnstown farms reported 4 irrigations per season and the Eaton farms 6 irrigations. There seemed little or no correlation between the number of irrigations and the yield. The yield did vary directly with the nitrate availability in the soil because the potatoes on land plowed from alfalfa sod outyielded the potatoes on other land by 55 sacks per acre.

Two of the farms reported no time spent in insect control, 3 reported it done by custom with no time estimate, and 10 reported from 0.25 hours per acre to 1.67 hours per acre. Some sprayed and some dusted by airplane and some reported a combination of the two methods. Dusting from the air was especially useful when the potato vines spread out making it difficult to get through with tractor or horse drawn machinery.

Table 17.--SUMMARY OF OPERATIONAL TIME IN CATEGORY 2 — TYPICAL CASE

| Operation | Implement width, feet | Times over | Crew | Man hours, 1 operation | For season's operations | |
|---|---|---|---|---|---|---|
| | | | | | Man hours | Tractor hours |
| Planting | 6 | 1 | 2 | 2.73 | 2.73 | 1.37 |
| Harrowing after planting | 15 | 1 | 1 | 0.44 | 0.44 | 0.44 |
| Cultivating | 6 | 2 | 1 | 0.72 | 1.43 | 1.43 |
| Ditching | 6 | 1 | 1 | 1.15 | 1.15 | 1.15 |
| Insect control | - | 2 | 2 | 0.45 | 0.89 | 0.89 |
| Irrigating | - | 5 | 1 | 1.36 | 6.80 | - |
| TOTAL HOURS PER ACRE | | | | | 13.44 | 5.28 |

In the harvesting operations it was found that 7 out of the 15 farms reported cutting or burning of vines; the others evidently waited until after the first frost before starting to harvest.

Digging time varied from 1 to 4 hours per acre with little difference between the 34-inch and 36-inch row machines. Speed of operation and freedom from breakdowns probably accounted for the variability.

Hand labor per acre in picking up the potatoes ranged from a low of 14 hours to a high of 42 hours. On Farms M-52 and M-82 there was no breakdown between

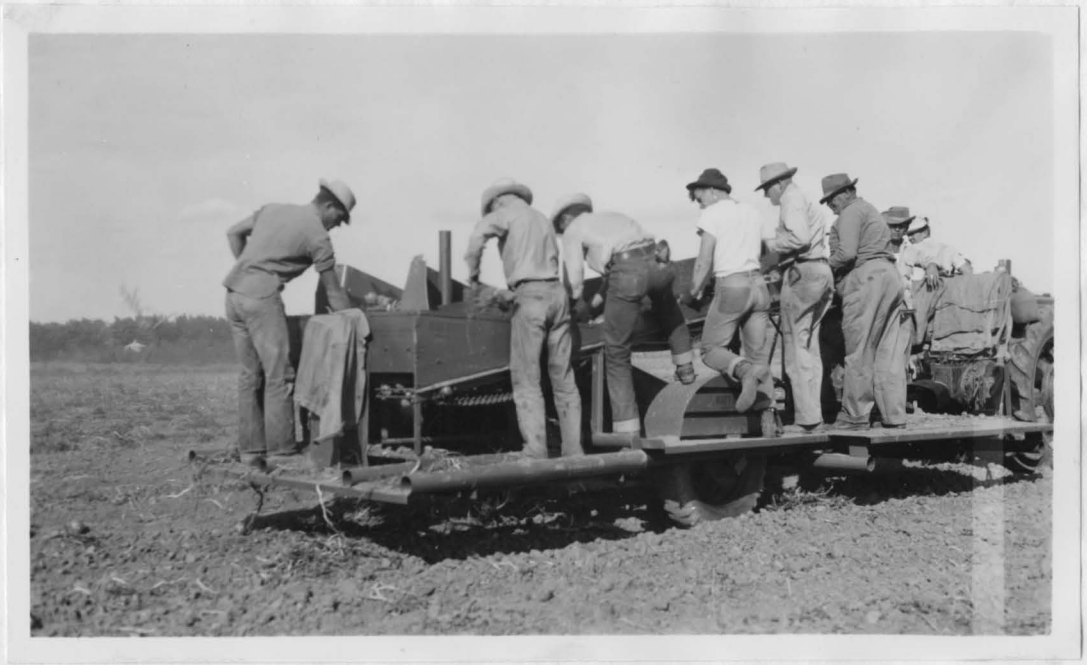
picking and hauling time. There was some correlation between the hand work and the yield. Two farms are omitted from this comparison because harvesting was done in whole or in part at contract rates with no man hours available.

The problem in potato production is to cut down on hand labor at harvest time. Potato combines are available but are not in general use because of occasional mechanical difficulties that develop when soils are in a cloddy condition.

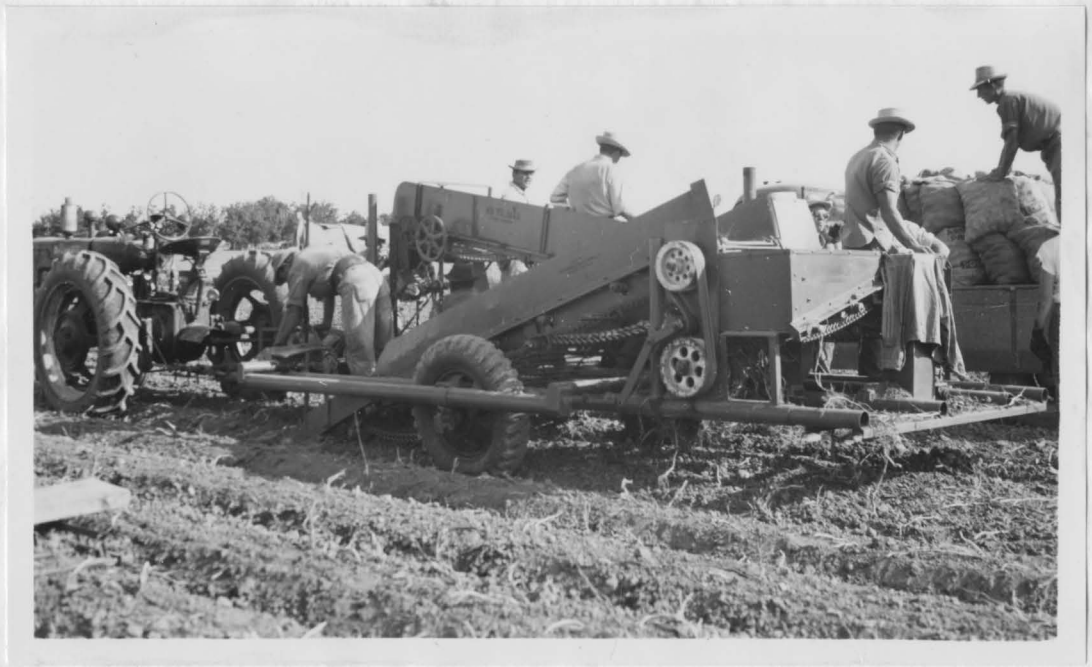
Table 13.--POTATO HARVESTING REQUIREMENTS AS RELATED TO YIELD

| Farm number | Yield per acre (hundred weight) | Hand labor picking (hours) | Hauling time (hours) | Time per hundred weight (hours) |
|---|---|---|---|---|
| M-58 | 344 | 25.60 | 21.12 | 0.135 |
| M-13 | 265 | 35.00 | [1]1.00 | 0.136 |
| E-72 | 182 | 17.45 | 8.42 | 0.142 |
| E-2 | 173 | 22.10 | 7.37 | 0.170 |
| E-20 | 153 | 16.33 | 6.11 | 0.146 |
| E-29 | 150 | 21.81 | 13.09 | 0.232 |
| E-41 | 150 | 24.48 | 10.88 | 0.236 |
| E-37 | 150 | 26.88 | 11.20 | 0.254 |
| E-1 | 134 | 16.20 | 6.40 | 0.169 |
| E-27 | 125 | 14.00 | 2.80 | 0.134 |
| E-28 | 125 | 30.00 | 8.00 | 0.304 |
| E-30 | 125 | 16.50 | 15.75 | 0.258 |
| E-39 | 120 | 42.76 | 4.27 | 0.392 |
| AVERAGES | 168 | 23.77 | 8.95 | 0.208 |

[1]Some of the potatoes sold in the field; hence, the low time



Picture 6.--Potato harvester, right side



Picture 7.--Potato harvester, left side

# Chapter IV

## FIELD LABOR REQUIREMENTS FOR BARLEY

There were 3,072 acres of barley in the two areas surveyed. This represented approximately 21.8 percent of the irrigated acreage.

Barley was grown both for grain and as a nurse crop for alfalfa. Detailed studies were made on 17 farms.

An over-all view of the barley production practices shows that an average of 15.22 man hours per acre were used to produce the crop.

By breaking the time down into the three categories of seedbed preparation, cultural, and harvesting, we have the comparative time used in the main operations.

Table 19.--BREAKDOWN OF MAN AND EQUIPMENT INPUTS

| Categories | Man hours | Tractor hours | Truck hours |
|---|---|---|---|
| 1 - Seedbed preparation | 2.44 | 2.44 | - |
| 2 - Cultural practices | 4.62 | 1.62 | - |
| 3 - Harvesting operations | 8.16 | 1.65 | 2.35 |
| TOTAL HOURS PER ACRE | 15.22 | 5.71 | 2.35 |

53.6 percent of the man hours were used in harvesting, 30.3 percent in Category 2 and 16.1 percent in Category 1.

42.7 percent of the tractor hours were used in Category 1, while the remainder of the tractor hours were almost equally divided between Categories 2 and 3, the actual percentage being 28.8 and 28.5, respectively.

There was little to be gained in comparing the yields of the two areas surveyed. The average production in the Eaton area was 29.8 hundred weight per acre and in the Mead-Johnstown area 30.1 hundred weight per acre, a difference of only 0.3 hundred weight.

There was, however, a noticeable variation in labor inputs of both man and tractor hours within the two districts.

Table 20.--A COMPARISON OF LABOR INPUTS, HOURS PER ACRE

| Area | Category 1 | | Category 2 | | Category 3 | |
|---|---|---|---|---|---|---|
| | Man hours | Tractor hours | Man hours | Tractor hours | Man hours | Tractor hours |
| Mead-Johnstown | 3.20 | 3.20 | 2.68 | 2.51 | 7.56 | 2.38 |
| Eaton | 1.75 | 1.75 | 6.35 | 0.84 | 8.71 | 1.65 |

In the Mead area, seed bed preparation constituted 23 percent of the total time used in producing an acre of barley, while in the Eaton area seed bed preparation used up 10.4 per cent of the time.

In the Mead area planting and cultural time took 20 percent of the total time, and in the Eaton area these operations took approximately 38 percent, or nearly twice, as much. This was largely due to the fact that in the Eaton district barley received 2 irrigations while in the Mead area 1 was usually sufficient.

In the harvesting operations there was less time variability. In the Mead district harvesting time involved 56 percent of the toatl time. In the Eaton area 52 percent of the man hours were employed in the harvesting.

Tractor time was 7.79 hours per acre in the Mead-Johnstown area and 5.71 hours per acre in the Eaton area, a difference of 2.08 tractor hours per acre,

indicating that more time was spent in working the ground in the Mead-Johnstown area. Much of this work was done in the fall of the year in the Mead-Johnstown area.

In analyzing the steps in barley production, seed bed preparation will be taken first. None of the 17 growers reporting in detail applied either barnyard manure or commercial fertilizer to fields to be planted to barley.

Seven growers followed beets with barley, 5 followed beans, 1 planted barley on potato ground, 2 planted barley on corn ground, and 2 followed barley with barley. The typical, of course, was to follow a row crop with barley.

In addition to the growers planting barley for the second time, 3 others plowed the ground to be planted to barley and a fourth plowed part of the barley ground. Two used 28-inch plows, one used a 32-inch and 2 used single-bottom plows. The average time for the 6 plowing was 1.47 hours per acre. One using a plow also spring toothed and 4 disked in addition to plowing.

Five renovated, using either a 6-foot or 7-foot implement. Two went over the field 2 times. An average gives 0.69 hours per acre for a single operation.

Four growers used a spring tooth harrow and 1 used a disk, while still another went over the field with both disk and spring tooth harrow.

An average time for spring toothing was 0.48 hours per acre for 1 time over and for disking 0.46 man-hours per acre. There was little to choose between the time used in disking or spring toothing, and not too much advantage in using a renovator. The greater variability existed when the field was gone over twice instead of once by either renovator, spring tooth harrow, or disk, but if 2 times over was practiced it was still less than the 1.47 hours used in plowing.

Fourteen of the barley growers used a spike tooth harrow in preparing the seed bed and 6 used a harrow to break "crust" after planting. Harrows varied in width from 12 to 20 feet, with 15 feet being the popular width used. Times over varied from 1 to 4, with 2 being the average. The average time for harrowing (all widths) was found to be 0.27 hours per acre for a single operation. The average time for 15-foot harrows was 0.28 hours per acre.

All 17 of the barley growers used a float in preparing seed bed. Times over varied from 1 to 3 and widths varied from 9 feet to 14 feet. Ten producers

reported going over the field more than once, and 12 feet was by far the most popular width.

The average time per acre for one operation was found to be 0.32 hours.

The speed of tractors drawing floats or levelers was found to vary from 2.48 to 4.48 miles per hours, with an average speed of 3.32 miles per hour. Average length of field was 60 rods. By using the Burdick equation, holding time for turns at one-half minute and 0.35 con- value for "A", we find that the work of leveling should take 0.326 hours per acre.

Three of the growers reported using a roller in seed bed preparation with an average time of 0.60 hours per acre, but this was not a typical operation in barley production.

The variability in seed bed preparation, all combinations, ranged from a low of 0.92 hours per acre to a high of 5.37 hours per acre. The low average for seed bed preparation consisted of 1 renovating, 1 harrow- ing, and 1 floating. The high average resulted from plowing with 18-inch plow, 1 disking, 3 harrowings, 3 floatings, and 1 rolling operation.

In Category 2 drilling is the first operation involved. We find drills varying from 6 to 10 feet in

width. The scatter in use was as follows:

| | |
|---|---|
| 6 feet - 1 | 9 feet - 2 |
| 7 feet - 4 | 9.3 feet - 2 |
| 8 feet - 1 | 10 feet - 4 |

Seven growers used 2 men to a drilling crew, while the remainder used only 1 man.

It can easily be seen with such a wide range that it is next to impossible to select a typical operation for drilling.

For purposes of comparison in this paper, the 10-foot drill with 1-man crew will be compared with a 7-foot drill with a 2-man crew. See Table 21.

Table 21.--HOURS PER ACRE FOR DRILLING BARLEY

| Drill and crew | Man hours | Tractor hours |
|---|---|---|
| 10-foot drill, 1-man crew | 0.59 | 0.59 |
| 7-foot drill, 2-man crew | 1.44 | 0.72 |

A saving of 0.85 man hours and 0.13 tractor hours could be saved by using a 10-foot drill with a 1-man crew instead of a 7-foot drill with a 2-man crew.

After planting, 6 of the barley growers went over the field once with a harrow. This was not a general practice and probably was due to an exigency of the season, such as a heavy rain crusting the ground before the

barley came up. The average time for the 6 that reported this harrowing was 0.26 hours per acre.

A ditching operation to facilitate irrigation of the crop was reported by 8 of the producers. The time for this varied from 0.04 to 0.40 hours per acre, with the average being 0.17 hours per acre.

Ditches were closed prior to harvesting, and this took on an average 0.08 hours per acre.

Irrigating time varied greatly between individual farms and between the two districts - 8 men reported irrigating 1 time, 8 reported 2 times, and 1 reported irrigating 3 times. As a rule, the Eaton producers irrigates 2 times and the Mead-Johnstown producers irrigated 1.5 times. Average time spent in irrigating varied from 0.24 hours per acre to a high of 12.12 hours per acre. The average time in the Mead-Johnstown area was 2.09 hours per acre and the average time in the Eaton area was 4.99 hours per acre.

There was no correlation found in comparing yields per acre with time of irrigating. The supply of irrigation water was ample in both areas and there were several rains. Differences in yield were probably due to fertility of soil rather than to water supply in the year in which this study was made. In the drouth year, it is quite likely a different conclusion would be made.

In harvesting operations 2 farms had a decided low figure in man hour inputs. Farm M-9, using a 7-foot combine, showed 1.66 man hours of labor used in harvesting and hauling 1 acre of barley. Farm E-23, using 5-foot combine, showed an average of 2.08 hours per acre to harvest and haul barley from 1 acre.

It is deeply regretted by the writer that the sample did not include more combines.

The remaining 15 barley producers bound, shocked and threshed the grain.

In binding, the time varied from a low of 0.35 hours per acre to a high of 2.0 hours.

Size of binders varied from 6 to 10 feet in width of cut.

Nine of the growers used a 2-man crew and the other 6 used a 1-man crew.

The 10-foot binder was favored over the others, in which there was a great variability, and will be used as the typical in comparing the efficiency of the operation.

The average time for the 10-foot binder was found to be 1.07 man hours and 0.69 tractor hours per acre.

The average of the other kinds of binders was 1.74 man hours and 1.33 tractor hours per acre.

By using the average tractor time, which by survey was 3.42 miles per hour, and the average length of the field as 60 rods, we find by the Burdick equation that a 10-foot binder could do the work in 0.37 hours per acre.

Following binding, the bundles were shocked by hand labor and allowed to dry until threshing by custom operated machinery was accomplished.

Shocking crews varied from 1 to 8, with an average of 3 to 4 men to a crew. The time to do 1 acre varied from a low of 0.89 man hours to a high of 5.60 man hours per acre. The average for the 15 farms harvesting barley by this method was 2.14 man hours per acre.

Threshing was done by crews of from 6 to 18 men. The average time was 4.41 hours per acre on the 15 farms harvesting by this method. The work was done by a custom arrangement and the information available for the work performed by tractors and trucks is not too accurate.

There were 2 main ways of doing this operation. One was to have 1 tractor run the threshing machine while 3 to 5 trucks, loaded by "spike" pitchers, hauled and bundled grain to the machine.

The other method in use was to have a second tractor equipped with hydraulic "farm hand" load the

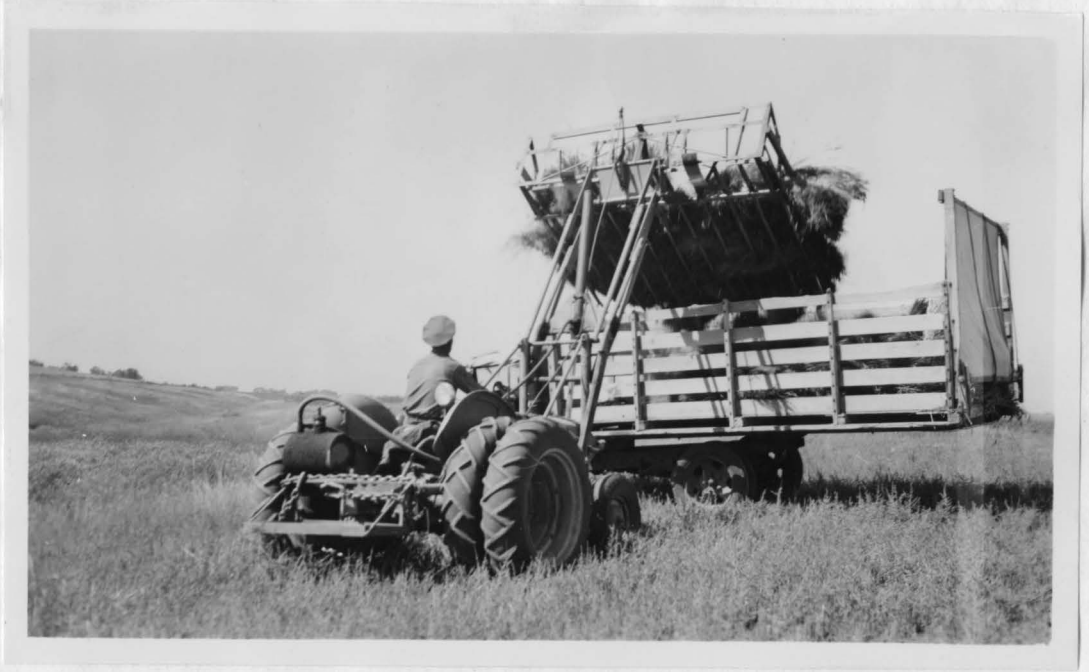
shocked grain on the trucks. There seemed little variation in the custom rate in the 2 methods, so there probably was little saved in substituting a second tractor for hand labor, although a saving of 1.08 man hours per acre was made where a hydraulic farm hand was used to replace spike pitchers.

Table 22.--HARVESTING METHODS COMPARED, HOURS PER ACRE

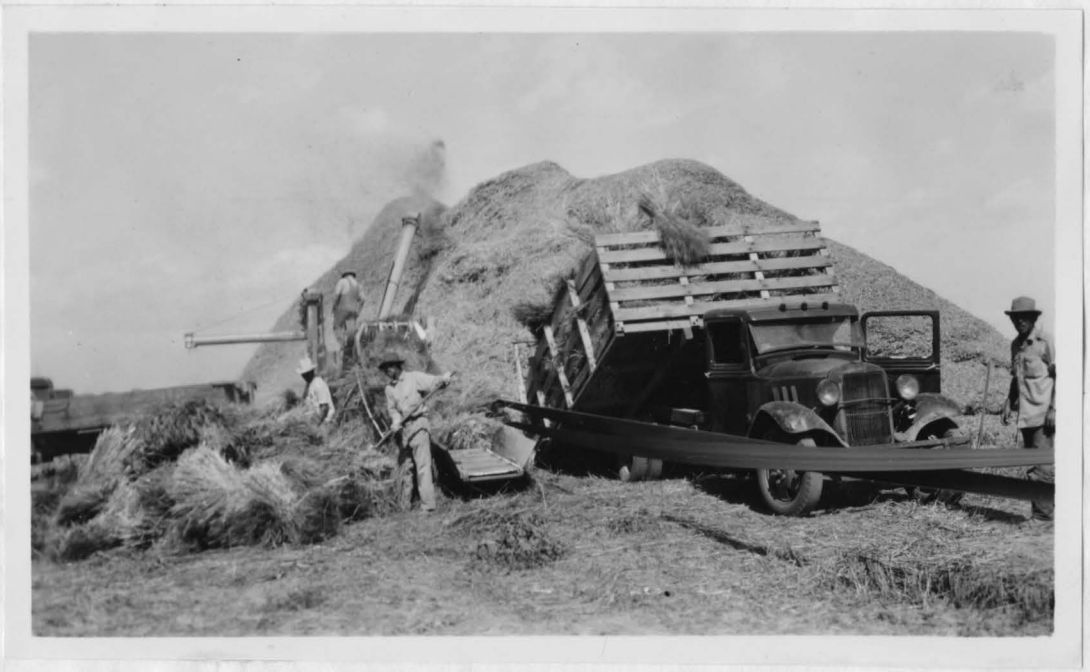
| Trucks loaded by | Man hours | Tractor hours | Truck hours |
|---|---|---|---|
| Tractor loader | 8.96 | 2.32 | 2.32 |
| Spike pitchers | 9.44 | 1.08 | 3.06 |

Hauling varied from 0.20 hours per acre to 1.39 hours per acre. Contributing causes were variance in yields to be hauled and distance to storage facilities.

Typical operations in barley production will be shown in Table 23.



Picture 8.--Loading bundled barley with hydraulic "farm-hand"



Picture 9.--Threshing barley (custom operated separator)

Table 23.--TYPICAL BARLEY OPERATIONS, HOURS PER ACRE

| Operation | Width, feet | Times over | Operation: Man hours | Operation: Tractor hours | Season's operation: Man hours | Season's operation: Tractor hours | Total hours: Man | Total hours: Tractor |
|---|---|---|---|---|---|---|---|---|
| Renovate, spring-tooth, or disk | 8 | 2 | 0.54 | 0.54 | 1.08 | 1.08 | | |
| Harrow | 15 | 2 | 0.28 | 0.28 | 0.56 | 0.56 | | |
| Float | 12 | 2 | 0.32 | 0.32 | 0.64 | 0.64 | 2.28 | 2.28 |
| Drill | 10 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | | |
| Ditch | - | 1 | 0.17 | 0.17 | 0.17 | 0.17 | | |
| Fill ditch | - | 1 | 0.08 | 0.08 | 0.08 | 0.08 | | |
| Irrigate | - | 2 | 1.66 | - | 3.32 | - | 3.92 | 0.60 |
| Bind | 10 | 1 | 1.07 | 1.07 | 1.07 | 0.69 | | |
| Shock | - | 1 | 2.14 | - | 2.14 | - | | |
| Thresh[1] | - | 1 | 4.11 | - | 4.09 | 1.01 | | |
| Haul | - | 1 | 0.94 | - | 0.94 | - | 8.24 | 1.70 |
| TOTAL | | | | | | | 14.44 | 4.58 |

[1]Trucks loaded by hydraulic "farm hand"

The typical operation shows a net saving of 0.78 man hours per acre and 1.13 tractor hours per acre. Most of this saving was in the use of a 10-foot drill.

A big saving could be made by a wider use of combines in harvesting. The average time for the two combines in this study was 1.87 man hours per acre. Comparing this with threshing, we find a saving of 5.43 man hours per acre.

# Chapter V

## FIELD LABOR REQUIREMENTS FOR BEANS

The dry bean production was found entirely within the Eaton area. In the surveyed area 1,471 acres were planted to beans. This represented in the year 1947, 10.44 percent of the irrigated crop acres on the surveyed farms.

Detailed records were made on 13 farms with a total of 378 acres planted to beans. Farm E-64 had two separate fields that were cultivated differently, so two records were used to represent this farm, making a total of 14 records of bean production.

Yield of beans ranged from 15.6 hundred weight per acre to 36.5 hundred weight per acre, with the average being approximately 21.6 hundred weight per acre.

Man hours per acre in producing a crop of beans under irrigated conditions ranged from a low of 20.47 hours per acre to a high of 69.89 hours per acre, the average being 34.08.

Tractor hours ranged from a low of 3.61 per acre to a high of 18.10 per acre.

As in the chapters devoted to other crops, the inputs of man and equipment hours have been broken down into the same three categories, giving hours per acre.

Table 24.--BREAKDOWN OF MAN AND EQUIPMENT INPUTS PER ACRE

| Categories | Man hours | Tractor hours | Truck hours |
|---|---|---|---|
| 1 - Seedbed preparation | 4.22 | 3.99 | - |
| 2 - Cultural practices | 17.06 | 3.09 | - |
| 3 - Harvesting operations | 12.80 | 1.94 | 2.51 |
| TOTAL | 34.08 | 9.02 | 2.51 |

In addition to tractor power, 6 of the 14 bean growers reported using some horse power on 1 or 2 of the operations. A comparison of farms using all tractor drawn implements with farms using part horse drawn is shown in Table 25.

Table 25.--HORSE AND TRACTOR DRAWN IMPLEMENTS COMPARED

| Farms reporting | Implements | Man hours | Tractor hours | Horse hours | Truck hours |
|---|---|---|---|---|---|
| 8 | All tractor drawn implements | 30.05 | 9.89 | - | 3.16 |
| 6 | Some horse drawn implements | 39.49 | 7.46 | 4.61 | 1.63 |
| 14 | AVERAGE all methods | 34.08 | 9.02 | 1.98 | 2.51 |

It was possible to use 20 separate operations in the production of an acre of beans, but most of the growers used fewer than this.

Seedbed preparation varied from a low of 2.28 man hours per acre to a high of 10.85 man hours per acre.

Operations in Category 2 ranged from a low of 3.71 man hours per acre to a high of 56.31 man hours per acre.

Operations in Category 3 ranged from a low of 3.33 man hours per acre to a high of 18.00 man hours per acre.

It is planned in this paper to analyze the significant variations and to determine as far as possible the reasons for these variations.

Fifty percent of the time used in producing an acre of beans was found to be in Category 2, reflecting the time spent in cultivation and irrigation. Some hand weeding also was found in this category.

Thirty-seven percent of the man hours were found to occur in Category 3, with the hand labor for harvesting contributing most of it.

Thirteen percent of the time was used in Category 1.

Fourty-four percent of the tractor time was

used in Category 1, 34 percent in Category 2, and 22 percent was found to be in Category 3.

It was determined that the bean crop usually followed sugar beets, 7 of the 14 farms reporting this to be the case. On 2 farms beans followed potatoes, on 2 others beans followed a previous crop of beans, and on 1 farm beans followed corn. Twelve out of 14 fields of beans were planted on ground that had been in row crop the year before. In 2 instances alfalfa sod was plowed under to furnish seedbed for beans.

The records indicate that on only one farm was there an application of barnyard manure. Commercial fertilizer was applied at the same time, and on another farm commercial fertilizer was applied in a separate operation. Farm E-69 shows 7.50 man hours per acre for manure, that is not found on the other farms in the study, but Farm E-69 also harvested with a combine and the total hours for producing an acre of beans was less than the average.

Ten of the 14 growers reported preparing the seedbed with plow. Seven using a plow also used a disk or renovator in addition.

Of the 4 not plowing, 3 used a renovator 2 to 3 times, and a fourth used a spring-tooth harrow and disk, once over with each.

In the plowing operation 5 growers used a 2-bottom 14-inch plow with an average time of 1.24 hours per acre. The average speed was found to be 3.92 miles per hour, and the fields averaged 80 rods in length. Using the Burdick equation for labor analysis, we find that 1.37 hours per acre should have been the time used in this operation.

Two producers used a 2-bottom 16-inch plow with an average time of 1.04 hours per acre. These plows were pulled at an average speed of 3.37 miles per hour. Using the Burdick equation, we find that this should have been in 1.29 hours per acre.

Two bean producers used a single-bottom 18-inch plow in plowing alfalfa stubble. In this case the average time was 2.11 hours per acre. The average speed was found to be 3.72 miles per hour. Using this speed in the Burdick labor analysis equation, it is found that the time should have been 2.23 hours per acre.

The tenth farm plowing reported using a 16-inch 1-bottom plow, with a time of 1.25 hours per acre, on land previously in row crop.

Four farms reported using a spring-tooth harrow one time over, with the average time being 0.69 hours per acre.

Three farms used a renovator to prepare the seedbed, and a fourth used a renovator in addition to plowing. Implements varied in width from 6 to 10 feet. Average time for going over the field one time was 0.61 hours per acre.

Six farms used a tandem disk in combination with either plow or renovator. Widths of this implement varied from 6 to 8 feet. Average time of one operation was computed to be 0.47 hours per acre.

Thirteen of the 14 farms used a spike tooth harrow from 1 to 5 times. Widths varied widely, 4 using a 15-foot harrow, 3 using an 18-foot, 3 a 14-foot, 3 a 12-foot, and 1 a 7-foot harrow. Average time for all widths was found to be 0.32 hours per acre for one time over.

Twelve of the 14 farms used a float from 1 to 3 times. Widths of this implement varied from 9 to 12 feet, with the 12-foot being the more popular. Average time, once over, for all widths was found to be 0.49 hours per acre.

The lowest input in seedbed preparation consisted of 1 renovating, 2 harrowings, and 1 floating. The highest input during seedbed preparation included application of barnyard manure.

After seedbed preparation is complete, beans are planted—usually in 22-inch rows, the same as beets, in order that the same planting and cultivating implements may be employed in the production of both crops. However, one producer used 20-inch spacing, one used 24-inch, and another 26-inch spacing. Owing to the small sample, a comparison of spacing widths will not be made. Twelve farms reported 1 man to a crew in planting, but 2 farms reported using 2-man crews.

Planting time ranged from 0.47 man hours per acre to a high of 2.75 man hours per acre. The high figure was due to the fact that one man had to replant half of his bean acreage because of a hail storm. The average for all farms reporting was 0.92 man hours per acre, but for the ones using 22-inch spacing between rows the average time was 0.78 man hours.

The cultivating was done with same width of implements in the planting. Ditching was also done by the same implement except for width of shovels used. Some farmers cultivated once and ditched twice, while the majority (8 out of 14) cultivated 3 times and ditched twice. The time for cultivating and ditching ranged from a low of 1.81 hours per acre to a high of 4.67 hours per acre, the average being 2.82 hours per

acre. Farm E-71 reported a harrowing operation after planting, but this was due to an exigency of the season and not a typical operation. The typical operation of cultivation and ditching called for 3 cultivations and 2 ditchings at 0.67 man hours per acre each or a total of 3.25 man hours per acre.

Labor inputs in irrigation varied both as to time actually spent with the water and with the number of times water was applied. The number of irrigations varied from a low of 4 to a high of 9 times during the growing season. There seemed to be no direct relation between the yield and the number of times water was applied, except in the case of the grower who only applied water 4 times. In this instance, the yield was one of the lowest reported. The 3 men who obtained the highest yields irrigated 5 and 6 times.

The average time for the 14 farms reporting showed an average of 7.42 man hours per acre. This figure is not greatly different from the 8.25 man hours per acre found in irrigating beets, a crop using the same row spacing.

Some of the farms reported considerable time spent in weeding the beans. The range was from a low of 1.25 man hours per acre to a high of 37.50 man hours per acre. Ten farms reported an average of 7.42 man

hours per acre in the weeding operation, while 4 evidently relied altogether on the cultivator to control weeds and used no hand labor in this operation. The widest variability of any of the operations was in this operation of weeding by hand.

Thirty-seven percent of the man labor inputs comes at harvest time. Shocking and threshing constitute the major operations calling for hand labor. However, in the case of combining, the man hours are considerably less than for the typical operation of threshing.

The 2 farms that reported harvesting by combine did so with an expenditure of 4.16 man hours per acre as compared to an average input of 14.24 hours per acre when threshing with custom-operated huller.

The first operation in harvesting was to cut the vines with a bean cutter. Some took 2 rows and some took 4 rows at a time. Of the farms reporting, 9 used a 4-row cutter with an average of 0.89 man hours per acre and 5 used a 2-row cutter with an average of 1.16 man hours per acre to accomplish the cutting operation.

The average length of rows was approximately 80 rods.

The average speed with which the 2-row cutter was drawn was 4.72 miles per hour, and the average speed for 4-row cutters was 4.28 miles per hour.

Picture 10.--Threshing beans (custom operated huller)

Picture 11.--Combining beans, International combine

Using the Burdick equation for labor analysis, we find that the 2-row cutter should do the work in 0.75 hours per acre and the 4-row cutter in 0.39 hours per acre.

Three of the farms reported using a side delivery rake to make larger windrows. The average time for this operation was 0.93 man hours per acre. Both farms employing a bean combine used the side delivery rake.

The 12 producers that employed a custom-operated huller used hand labor to shock the beans. One producer that received a high yield re-set the shocks just before threshing in order that thorough drying would take place.

Shocking time varied from a low of 1.50 man hours per acre to a high of 13.33 man hours per acre. The average was 5.08 man hours per acre.

Threshing time varied from a low of 4.94 man hours per acre to a high of 10.50 man hours per acre. The average was 7.19 man hours per acre.

Size of crew ranged from 10 to 15, with 13 a fair average.

There was a wide variability in use of tractors and trucks in the threshing operation. Eight farms reported using trucks to haul in the shocked beans to the huller and 4 reported using tractor drawn wagons for this

purpose.

Hauling time varied from a low of 0.33 hours per acre to a high of 5.0 hours per acre. There was no way to tell how much of this variability was due to variability of distance to market and how much to variability in yield.

Typical operations for bean production are given in Table 26.

Table 26.--TYPICAL OPERATIONS IN BEAN PRODUCTION

| Operation | Width in feet | Times over | Hours per acre | | Total hours | |
|---|---|---|---|---|---|---|
| | | | Man hours | Tractor hours | Man hours | Tractor hours |
| Plowing | 2.3 | 1 | 1.24 | 1.24 | | |
| Harrowing | 15.0 | 3 | 0.96 | 0.96 | | |
| Floating | 12.0 | 2 | 0.46 | 0.46 | 2.66 | 2.66 |
| Planting | 2.3 | 1 | 0.78 | 0.78 | | |
| Cultivating | 2.3 | 3 | 1.91 | 1.91 | | |
| Ditching | 2.3 | 2 | 1.34 | 1.34 | | |
| Weeding | - | 1 | 7.42 | - | | |
| Irrigating | - | 5-6 | 7.80 | - | 19.25 | 4.03 |
| Cutting | 2.3 | 1 | 0.83 | 0.83 | | |
| Shocking | - | 1 | 5.08 | - | | |
| Threshing | - | 1 | 7.19 | 0.89 | | |
| Hauling | - | 1 | 0.83 | - | 13.93 | 1.72 |
| TOTAL | | | | | 35.84 | 8.41 |

It will be noted that man hours are 1.76 more in the typical than in the breakdown by categories in Table 24. This is mainly because the typical includes weeding whereas 4 farms did not report any man hours used in weeding.

The largest saving of time would come in the use of combines to harvest the crop. If the limitation of the small sample is not too great, it can be seen that a total of 10 hours per acre might be saved by using a combine instead of waiting until a custom thresher could be employed.

If hand weeding could be eliminated by more efficient cultivators, another considerable saving in man hours of labor could be made.

The 7 farms with the lowest input of man hours per acre showed an average yield of 20.53 hundred weight per acre, or a ratio of 1.18 man hours labor per hundred weight of beans produced.

The 7 farms with the highest input of man hours of labor (average 43.88) showed an average yield of 23.26 hundred weight per acre. Expressed in man hours per hundred weight of beans produced, this is 1.88.

In the case of beans, additional yield was not proportional to extra inputs of man hours of labor utilized.

# Chapter VI

## COMPARISON OF FOUR CROPS

Table 27 gives a comparison of the labor and tractor inputs per acre of the four crops studied in this paper.

Approximately an acre of beans required twice the man hours reported for an acre of barley. Potatoes required four times as many man hours as barley, and sugar beets took six times as many man hours as barley.

In order to compare the results as determined by the survey method with those calculated by means of the Burdick equation, four implements in common usage in the production of all four crops have been used. These are: the 2-bottom 14-inch plow, the 1-bottom 16-inch plow, the 15-foot harrow, and the 12-foot float. The results of this comparison appear on Tables 28, 29, 30, and 31.

Table 27.--INPUTS OF MAN HOURS AND OF TRACTOR HOURS FOR THE FOUR CROPS

| Categories | Beets | | Potatoes | | Barley | | Beans | |
|---|---|---|---|---|---|---|---|---|
| | Man hours | Tractor hours | Man hours | Tractor hours | Man hours | Tractor hours | Man hours | Tractor hours |
| 1 - Seedbed preparation | 7.32 | 5.35 | 10.44 | 7.18 | 2.44 | 2.44 | 4.22 | 3.99 |
| 2 - Cultural practices | 46.56 | 3.73 | 13.46 | 5.08 | 4.62 | 1.62 | 17.06 | 3.09 |
| 3 - Harvesting operations | 37.12 | 3.36 | 35.24 | 2.99 | 8.33 | 1.65 | 12.80 | 1.94 |
| TOTAL, PER ACRE | 91.00 | 12.44 | 59.14 | 15.25 | 15.39 | 5.71 | 34.08 | 9.02 |

Table 28.--PLOWING WITH 28-INCH PLOW

| Length of field (rods) | Number farms | Average speed | Time by survey | Time by equation |
|---|---|---|---|---|
| 40 - 50 | 8 | 4.28 | 1.30 | 1.46 |
| 50 - 60 | 6 | 3.58 | 1.84 | 1.55 |
| 60 - 70 | 1 | 3.32 | 1.00 | 1.60 |
| 80 + | 7 | 3.30 | 1.09 | 1.66 |
| TOTAL FARMS | 22 | | | |
| AVERAGES | | 3.62 | 1.31 | 1.57 |

The time by survey in the 60- and 80-rod categories is obviously lower than could be accomplished. Even if no time was lost in turns, rest, and service, the work could not have been done in the time reported to the enumerator.

Table 29.--PLOWING WITH 16-INCH PLOW

| Length of field (rods) | Number farms | Average speed | Time by survey | Time by equation |
|---|---|---|---|---|
| 30 - 40 | 6 | 3.63 | 1.97 | 2.16 |
| 80 | 4 | 2.81 | 1.45 | 3.26 |
| TOTAL FARMS | 10 | | | |
| AVERAGES | | 3.22 | 1.71 | 2.71 |

The time as given in the survey column is obviously too low a figure. Even if no time was allowed for turns, rest, and service, the work could not be accomplished in such a low time per acre. This is a good illustration of a weakness of the survey method in determining field labor requirements.

Table 30.--HARROWING WITH 15-FOOT HARROW

| Length of field (rods) | Number farms | Average speed | Hours by survey | Hours by equation |
|---|---|---|---|---|
| 30 - 50 | 11 | 3.80 | 0.38 | 0.26 |
| 50 - 60 | 6 | 4.23 | 0.34 | 0.22 |
| 60 - 70 | 2 | 3.82 | 0.25 | 0.23 |
| 70 - 80 | 1 | 4.12 | 0.18 | 0.22 |
| 80 - 90 | 13 | 3.46 | 0.26 | 0.23 |
| 120 | 1 | 3.50 | 0.22 | 0.23 |
| TOTAL FARMS | 34 | | | |
| AVERAGES | | 3.82 | 0.27 | 0.24 |

The hours determined by equation are consistently lower than those determined by survey, because farmers rarely use fully the effective width of this implement.

Table 31.--FLOATING WITH 12-FOOT FLOAT

| Length of field (rods) | Number using | Average speed, miles per hour | Hours by survey | Hours by equation |
|---|---|---|---|---|
| 40 - 50 | 11 | 3.54 | 0.51 | 0.33 |
| 50 - 60 | 6 | 3.75 | 0.47 | 0.29 |
| 60 - 70 | 3 | 3.85 | 0.42 | 0.28 |
| 70 - 80 | 0 | - | - | - |
| 80 | 12 | 3.17 | 0.44 | 0.31 |
| 140 | 1 | 4.25 | 0.24 | 0.23 |
| TOTAL USERS | 33 | | | |
| AVERAGES | | 3.71 | 0.42 | 0.29 |

The hours as given by the equation are consistently lower because farmers rarely use the effective width of this machine.

Table 32.--OPERATIONS IN CATEGORY 1 (SUGAR BEETS) THAT CAN BE ANALYSED BY USE OF BURDICK EQUATION

| Operation | Width, feet | Length field (rods) | Average speed, miles per hour | Hours by survey | Hours by equation |
|---|---|---|---|---|---|
| Plowing | 2.3 | 60 | 3.57 | 1.40 | 1.56 |
| Disking | 8.0 | 75 | 3.87 | 0.52 | 0.42 |
| Harrowing | 15.0 | 60 | 3.75 | 0.29 | 0.24 |
| Floating | 12.0 | 60 | 3.75 | 0.42 | 0.27 |
| TOTAL HOURS PER ACRE | | | | 2.63 | 2.49 |

It is observed that there is a difference of 0.14 man hours when labor requirements as determined by the survey method are compared with labor requirements as determined by the Burdick equation in analysis of this Category. Categories 2 and 3 could not be similarly compared because of the large amount of hand labor operations that are found in them.

# Chapter VII

## SUMMARY

The main purpose of this study was to analyze the survey records showing the time required per acre, estimated by two methods, for four crops grown in Weld County in 1947.

The analysis showed the over-all per acre labor requirements for specific operations. Where possible, the time for these same operations was calculated based upon the farmer's estimate as to the width of the machine, speed of travel, and length of field. These estimates were combined with a uniform time of one-half minute for turns and a service allowance of 0.35 in the Burdick equation in making these calculations.

Briefly, the time per acre calculated by the Burdick equation indicated the need for greater care and refinement in securing original farmer's estimates. In some cases, farmers estimated total hours per acre as being less than required for the given widths and speeds when no allowance was made for any time for turns or rest.

The errors in the over-all estimates were not identified as to specific cause, but apparently were to be found either in stating effective width of implement or actual speed of travel.

For some operations the over-all estimate apparently allowed for more than once over although the farmer claimed that the operation was performed only once.

Table 27 shows that the total time per acre used in producing the several crops in 1947, as determined by the survey, was as follows:

| | Hours per acre | |
|---|---|---|
| Crops | Man | Tractor |
| Sugar beets | 91.00 | 12.44 |
| Potatoes | 59.14 | 15.25 |
| Barley | 15.39 | 5.71 |
| Beans | 34.09 | 9.02 |

It is impossible to check the hand labor operations by the Burdick equation.

It was possible to check the field operations done by specific implements by the Burdick equation.

For example, seedbed preparation time in the production of sugar beets was calculated to be 2.63 man

hours per acre by the survey method, while by the Burdick equation the time was determined to be 2.49.

For other crops and other operations there was considerable variation in the hours per acre, as shown by the two methods of analysis.

After an over-all picture was calculated from the survey material, a typical set of operations used in producing the several crops was selected and compared with the over-all view.

Typical times over of the several operations performed and also typical crews that performed these operations were selected for the four crops.

In many instances, it was apparent that the previous crop had an appreciable influence on the time needed to prepare the seedbed, but this was not always true for all crops.

The fourth problem in the study was that of the variation in irrigating time as affecting yield. This could not be proved in 1947 because there was ample water for all crops. In a year of less favorable moisture supply, some interesting information might be collected on this point.

Wherever the substitution of specific pieces of equipment had an appreciable effect on the hours per

acre, this practice was noted. In instances where the sample was small, the recommendation for a substitution of equipment should be taken "with a grain of salt."

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