AGRICULTURAL ADJUSTMENT UNIT · UNIVERSITY OF NEWCASTLE UPON TYNE

Efficient Labour Organisation

by N. W. Dilke

TP12

THE AGRICULTURAL ADJUSTMENT UNIT
THE UNIVERSITY OF NEWCASTLE UPON TYNE

In recent years the forces of change have been reshaping the whole economy and, in the process, the economic framework of our society has been subject to pressures from which the agricultural sector of the economy is not insulated. The rate of technical advance and innovation in agriculture has increased, generating inescapable economic forces. The organisation of production and marketing, as well as the social structure, come inevitably under stress.

In February 1966 the Agricultural Adjustment Unit was established within the Department of Agricultural Economics at the University of Newcastle upon Tyne. This was facilitated by a grant from the W. K. Kellogg Foundation at Battle Creek, Michigan, U.S.A. The purpose of the Unit is to collect and disseminate information concerning the changing role of agriculture in the British and Irish economies, in the belief that a better understanding of the problems and processes of change can lead to a smoother, less painful and more efficient adaptation to new conditions.

Publications

To achieve its major aim of disseminating information the Unit will be publishing a series of pamphlets, bulletins and books covering various aspects of agricultural adjustment. These publications will arise in a number of ways. They may report on special studies carried out by individuals; they may be the result of joint studies; they may be the reproduction of papers prepared in a particular context, but thought to be of more general interest.

The Unit would welcome comments on its publications and suggestions for future work. The Unit would also welcome approaches from other organisations and groups interested in the subject of agricultural adjustment. All such enquiries should be addressed to the Director of the Unit.

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PREFACE

The Agricultural Development Association and the Agricultural Adjustment Unit are running a series of courses on various aspects of farm business management.

Several of the papers, prepared by specialists in their fields, deal with technical, legal and financial subjects in an authoritative way and are being issued as Technical Papers so that a wider audience than those attending these well-booked courses can benefit from the information which has been assembled.

February, 1970.

EDITOR'S NOTE

The author of TP.12 is Senior Lecturer in Work Study, Seale Hayne Agricultural College. In this paper, Mr. Dilke has described the various techniques available to analyse and budget labour requirements.

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Introduction

The increasing costs per unit of labour and machinery and the steady decline in the labour force make it necessary for all engaged in agriculture to consider how farm labour can be used more effectively. In any study designed to increase efficiency, machinery and buildings must be considered in conjunction with the use of labour. Implements and machinery are the farm workers tools and buildings provide an artificial environment. However hard the farmworker works and however skilled he is at his job the implements and buildings will stamp a basic work pattern on the task. Poor building layouts, machines which are designed as highly efficient units from the engineering point of view but lack consideration of the vital relationship between man and machine, and the poor design of working systems all contribute to a performance at a level of efficiency which is below the optimum. The first objective of this paper is to outline some of the methods which can help to plan efficient whole farm working systems; systems which not only increase output and reduce costs but remove some of the frustrations which a poor system imposes on the workers.

Historically speaking, labour planning on the farm has tended to be divided into two sections. The first which one might call "whole farm" planning sets out to ensure that the chosen enterprises and systems of cropping and stocking make the best use of labour throughout the year. The second section examines the individual operations to ensure that each task is carried out as efficiently as possible. The two are closely linked and have as a basic requirement data. As a general rule the closer the data is to the particular farm the more realistic will be the planning. There are many so-called "standards" which are used, but great care must always be taken to make sure that the "standard" fits your situation. The most reliable data is that recorded on your own farm. Failing this, "standards" or data recorded elsewhere should be modified in the knowledge of the conditions relating to climate, management, land, labour, machinery, buildings and stock on your own holding.

How Much Labour

Under this heading are posed many questions which lead from this general question how much full-time labour should the farm carry? Should the use of a contractor be contemplated; can casual labour be employed; could more overtime be worked by a smaller full-time staff; can changes in cropping, stocking, machinery or method be made and if so how much and at what period of the year? Whilst the Gross Margin system for Farm Business Analysis has proved excellent for overall planning it has only limited use when examining the use of labour and machinery on individual enterprises because costs are not allocated to each enterprise. Comparing efficiency factors with standards may indicate excessive use of these resources but give little indication of why this should be so. Those of you that have tried using time sheets in an attempt to allocate labour to each enterprise will realise that this is fraught with danger. The main reasons spring to mind, firstly, work does expand to fill the time available and secondly, the demand which enterprises make on labour at peak periods is more important than their total labour demand.

Labour Profile

On small farms for instance, those employing only one or two men, or when the farming system is simple with only one or two enterprises, there will probably be no need for formal analysis. However, when a number of men are employed on a number of enterprises a more formal documentation can give a clearer picture of the situation.

Profiles can be compiled from standards. These may be standard man days or standard man hours and usually refer to the number required in each enterprise per month or even half month. Figure 1 shows an example of this for a 495 acre farm employing 6 field workers and a cowman. The farmer himself contributes the work of half a man to the livestock enterprise. The cropping and stocking of this farm were as follows:-

Cropping	- grazing	90 acres
	- silage	70 acres
	- potatoes	35 acres
	- winter wheat	60 acres
	- barley	240 acres
Stock	- milk cows	80
	- follower units	20

In order to keep this chart simple, the full enterprise breakdown that standards would have allowed is not shown. The peaks and distribution of labour between enterprises are clearly shown.

To nullify the effect of standard figures, which are averages of a widely fluctuating performance, actual farm performance where known can replace them. Figure 2 shows a labour profile for this farm using as much farm data as possible. Of particular interest is the difference in Spring use of labour. Even though data which more exactly reflects the actual performance on the holding have now been used, the labour profile technique still has several disadvantages. Prominant among these is the difficulty of seeing how the men are deployed, or the composition of a gang working on a job. Gang sizes change with charges in mechanization so it may not be clear what effect a new machine or change of working method will have on labour usage. Because of the monthly block allocation of time the labour profile may show a peak labour demand which in practice may well be spread into the preceeding and succeeding months.

Gang Work Day Profiles

A method which meets the criticisms voiced above is to construct profiles on the basis of "gang work days". (G.W.D.) A G.W.D. consists of 8 hours and is the measure of the time taken by the gang to carry out a particular task. As an example, if a gang of 4 men were necessary to carry out a task taking 16 hours this would be 2 G.W.D. but on a standards basis this would be shown as 8 standard man days. The information for each task is charted on a sheet showing the number of 8 hour days available for work in each month.

Messrs. Wallace and Burr, who suggested this method, compiled Table 1 which indicates the number of work days available. Table 1 was worked out for East Anglian conditions and takes into account weather, sickness, holidays, etc., which are balanced by reasonable overtime.

TABLE 1

WORK DAYS AVAILABLE

Month	W.D.	Month	W.D.
January	14	July	24
February	17	August	24
March	20	September	22
April	22	October	19
May	24	November	16
June	25	December	15

NOTES: (a) 1 Work day (W.D.) = 8 hours.
(b) This scale was worked out for East Anglian conditions and may need adjustment elsewhere.

SOURCE:- Wallace D.B. and Burr M. "Planning on the Farm". University of Cambridge, Farm Economics Branch, 1963. Farm Economics Report No. 60.

In general this technique is of greatest use for large arable farms. Allocations of stockmen is usually in one man units, their time that can be devoted to arable being regarded as overtime or casual.

The information required to make up a "Gang Work Day" profile can be classified under each crop and should be as follows -

1. Activity - ploughing, drilling, harvesting, etc.
2. Period - dates between which the job should be completed.
3. Acreage -
4. Acres per G.W.D. - team output.

5. G.W.D. required - number of G.W.D. to complete the activity (crop acres divided by acres per G.W.D.)

6. Work days available -

7. Gang composition - number of regular workers in gang. The number of casual workers and tractors can also be shown.

8. Number of gangs - if the work days available are less than the G.W.D. required more than one gang will be required.

Gang Work Day profiles can be drawn up for the whole year to indicate peak periods of labour demand. These peaks are important because it is these that determine the number of men employed. Further, the crops which create the peaks can be identified and changes contemplated and entered on the profile. Of equal importance are the troughs. Modifications in cropping can be contemplated and further mechanisation of operations occurring during these periods may be avoided as the indication is that labour is already under-employed.

In many cases there is no need to draw out G.W.D. profiles for the whole year. Profiles for the periods of peak requirements of labour and machinery similar to figure 3 can be drawn. This shows a G.W.D. profile for Spring arable work on the farm previously considered. On this particular farm Spring and Autumn were the two periods of the year with a higher labour demand and changes to reduce this were obviously worthwhile. Data for contemplated changes can be obtained from a number of sources notably Farm Economics Branches and the N.A.A.S. but care must be taken to make sure it fits your farm. Each possibility can be entered on a G.W.D. profile to examine the labour and machinery picture. In all cases of change a partial budget should be worked out. The example used in this section was modified from the work by Brownaand Atkinson who have shown the G.W.D. profiles and budgets for change in "Planning Labour Needs" Power Farming April 1969.

Labour and Machinery Scheduling

Whilst on the majority of farms the Gang Work Day method outlined is a very useful weapon for assessing changes in labour use, on some arable farms which are already at a high level of efficiency more sophisticated techniques of labour and machinery scheduling may well be necessary. Other industries use a number of techniques for estimating the output capacity of a number of machines, planning work schedules and completion dates. These require detailed performance times and if there is a large variation in individual times, which there usually is in agriculture, a measure of this variation.

The "average" time, if it is a true average, gives only a 50% change of completion on time. This may be acceptable, according to the value of the crop and alternatives, but if it is not, further consideration must be given to the probability of completing the various activities on time. To do justice to these techniques performance times, work days available and in fact all data should be expressed as an average and a measure of the variability of the average. Probabilities of completion at various times can be calculated and related to the increased cost of labour and machinery to avoid loss of crop and the cost of lost crop.

In practice farmers usually carry excess capacity in their equipment and even excess labour. This helps to reduce the risk inherent in the industry due to the considerable variability in the time needed to complete operations and the time available to carry them out. Normally this can be less costly than detailed scheduling but if carried to extreme labour and machinery costs can rise out of all proportion.

Organising the Individual Operation

The last section was mainly about arable situations. In this section although reference is made to livestock units, examples are from the arable situations. This does not mean that the techniques are not applicable to livestock units. The larger the unit the more necessary these techniques are and if they are ignored in for instance units of say 300 to 400 cows, costly blunders can be made.

As soon as one proposes to discuss work routines and efficiency at the work place the cry is liable to go up. "That is Work Study". This of course is correct but in saying this many forget that it is only a part of work study and the organisation of labour does not require all the techniques of work study to be used. If they are used the enquiry can become top heavy and frequently finishes by proving what it was not asked to prove.

Work Study

Work study is usually neatly divided into two sections.

Work Measurement which sets out to find the time a skilled worker will take to carry out a defined task at a defined level of performance. This is a very detailed process the purpose of which is to get a standard at a defined level of performance, not an average. As well as timing the task, it involves rating the operator for speed and effectiveness and calculating machine performance.

Method Study is the systematic recording and critical examination of existing and proposed ways of doing work as a means of developing and applying easier and more effective methods and reducing costs.

There are six standard steps.

1. Select the work to be studied and define the problem. This will invoive getting the correct term of reference.

2. <u>Record</u> the relevant facts of the present and proposed situation. This is mainly carried out using different types of chart.

(a) Process charts divide the task under five symbols.

○ - operation which produces or accomplishes something.

□ - inspection to verify quantity or quality.

⇨ - transport when something moves or is moved.

D - delay or awaiting next activity.

▽ - storage or held against unauthorised removal.

These charts show the sequence of activities of one subject (worker, material or equipment).

(b) Flow diagrams indicate movement. These usually depict the movement on a scale drawing of the activities shown on a process chart.

(c) String diagram indicate movement by means of a piece of cotton tracing the movement path on a scale-plan. By measuring the cotton the distance moved can be found.

(d) Multiple activity charts relate the activities of a number of subjects to a common time scale.

3. <u>Examine</u> the facts critically.
The main activities are rigorously questioned under headings of what is achieved? Why is this achievement necessary? Alternatives are sought and their suitability and feasibility checked. The questioning continues in a similar fashion under the main headings of How? When? Where? and Who? Carried out correctly, critical examination will produce a number of alternatives for all the main activities.

4. <u>Develop</u> the alternatives into an improved and viable method.

5. <u>Install</u> the new method as standard.

6. <u>Maintain</u> the method by routine checks.

Types of Work Study Problems

It should be obvious that if one is contamplating a major change the full method study procedure backed up with work times obtained by work measurement is essential. Under these conditions one wants to plan for the future, to be inventive. It is in helping to solve these CREATIVE type problems that critical examination is of prime importance. However many problems in agriculture are not of this type and to set about using critical examination in these circumstances is time wasting and often misleading.

What about the day to day problem where something seems to have gone wrong. This could be a flare-up in mastitis, a task taking too long to perform or a strike. These problems are of the DIAGNOSTIC type; when you can establish the exact reasons or conditions the cure is self evident. Obviously if you are to make the correct diagnosis the work study techniques of measurement and recording are of considerable value. Like the family doctor you cannot prescribe the right medicine without first making the correct diagnosis. Obviously you must question and whilst the full procedure of critical examination need not be used a knowledge of this technique is valuable. It always pays to remember that it is the achievement that is the most important.

There are many other problem situations on farms when nothing basically has gone wrong and large scale changes are not contemplated. The problem is to make the best use of available resources, OPTIMISING is the cure. Similarly to our diagnostic problems optimising problems require the facts of the situation to be obtained. The majority of problems involving a number of men and machines are of this type. Whether the man is working in a parlour with a number of milking units or a harvester or planter is working in the field with a number of attendant tractors and trailers the problems encountered in organisation are of the same basic type.

Optimising situations are dealt with in more detail but it must first be made clear that all problems do not fall neatly into one or other of these three classes. What starts as one type frequently develops into one or both of the others. When carrying out work studies we find it essential to get clear terms of reference at the select stage. This will then give us an indication of how far the problem solving has to be taken.

Balancing Teams of Men and Machines

Systems involving only one man and one machine present few problems, it is only when a number of men and machines must be co-ordinated to work as a balanced system that outputs can drop well below optimum. Before one can plan a system, detailed knowledge of man and machine outputs and working conditions are necessary.

Armed with these facts it is possible to plan and compare working systems. If a system is allowed to develop by trail and error unseen reductions in output can occur. There are a number of ways in which management can measure the potential output of a system.

Team balance equations

Probably the quickest method of arriving at the optimum transport organisation for a task where a number of tractors, stillages or lorries are carting from a harvester is to use equations. If reliable work time data is substituted for the symbols in the equations team balance can be quickly assessed. For special circumstances special equations must be compiled. However if the average working speed and capacity of all the transport units is approximately the same and these are waiting on one harvester the equations given below can be used.

It must be clearly understood that two distinct systems of harvesting can be used. Type 1 where a harvester discharges its product either direct or from a tank into a transport unit which has a separate power unit and is always under the charge of its own driver. Type 2 where the transport unit into which the harvester discharges is towed by the harvester and exchanged for an empty one when full.

These output equations are built up as follows.

Description		Symbol	Unit
Capacity of trailer		C	ton
Field machine or field team output		M	tons/hour
Time to load 1 transport unit	$\frac{60C}{M}$ =	L	min.
Change over time common to harvester and transport unit which is done outside loading time e.g., discharge from tank, manoeuvring into position, hitch and unhitch etc.		D	mins.
Time transport unit is away from harvester. Includes transport, unload etc.		A	mins.

Systems of Type 1

Type 1 systems have an equal number of transport units as transport drivers. For example this implies that trailers are towed alongside a harvester by a separate tractor which requires a separate driver.

Number of transport units to balance system $1 + \frac{A}{L + D} = N_c$

Actual number of transport units (a whole number). N_a

Description	Symbol	Unit
Waiting time in system $\left(N_a - 1\right)\left(L+D - \frac{A}{N_a - 1}\right) =$	W	min.

If W is positive (+) it represents transport waiting time per load.

If W is negative (-) it represents harvester waiting time per cycle of N_a loads.

System output - if transport waits $M\left(1 - \frac{D}{L+D}\right) =$	S	tons/hour
- if harvester waits $\dfrac{M \times L}{L+D+\frac{W}{N_a}} =$	S	tons/hour
Capacity of transport unit to balance system $\frac{M}{60}\left(\frac{A}{N_a - 1} - D\right) =$	C	ton

Systems of Type 2

Type 2 systems have one more transport unit than transport drivers. For example the harvester may tow a trailer which it exchanged for another empty trailer when loaded.

Number of transport units to balance system $1 + \frac{A+D}{L+D} =$	N_c	
Actual number of transport units (a whole number)	N_a	
Waiting time in system $\left(N_a - 1\right)\left(L+D - \frac{A+D}{N_a - 1}\right) =$	W	min.

If W is positive (+) it represents transport waiting time per load.

If W is negative (-) it represents harvester waiting time per cycle of N_a-1 loads.

System output - if transport waits. $M\left(1 - \frac{D}{L+D}\right) =$	S	ton/hour

Description		Symbol	Unit
System output - if harvester waits.	$\dfrac{M \times L}{L+D + \dfrac{W}{N_a - 1}} =$	WS	ton/hour
Capacity of transport unit to balance system	$\dfrac{M}{60}\left(\dfrac{A + D}{N_a - 1} - D\right) =$	C	ton

Multiple Activity Charts

For those who prefer to visualise a system or wish to examine more complex systems than the simple equations fit, charts can be used. Multiple activity charts consist of a number of bars each representing one subject (man or machine) which are plotted side by side against a common time scale.

As an example let us consider a system of type one. Chart 1 shows a balanced system where two transport units run alongside a harvester. The time that one transport is away is exactly balanced by the time the other transport takes to load. Loading time takes 15 mins. and transport and unloading takes 15 mins. A farmer might consider towing the trailer behind the harvester i.e. introducing a system of type two. Loading, transport and unloading times will remain the same but a time for changing trailers, in this case say 5 mins. must be introduced. The result shown in chart 2 indicates a reduction in tons per hour but an increase in tons per man hour. Using average times for the holding this is a realistic method to assist in making the first decision; which system.

Of course transport times will vary from one field to another. Having selected the system shown in chart 1 in the next field transport time increases from 5 mins. to 10 mins. Chart 3 shows the effect indicating the resultant drop in output and waiting time for the harvester. Harvester waiting time in cases like this can be construed by both farmer and workers as wasted time. The temptation is for the harvester driver, knowing he has to wait, to slow down. The effect is shown in chart 4 where the same load of 3 tons now takes 20 mins. to obtain instead of 15 mins. with the consequent loss in outputs. To counteract the lost output due to an increased transport time an extra transport unit could be used. Chart 5 shows such a system which can be directly compared with chart 3. Output per hour has been increased to maximum (i.e. the same as chart 1) whilst output per man hour remains the same and transport waits.

When the transport has to wait there is a tendency to try to reduce this, by changing trailers before a full load is obtained. With systems of type 1 this generally will not cause a serious fall in output. However, with type 2 systems more frequent change over can reflect in a lower output. Chart

6 shows the effect of increasing transport time from 5 mins. to 10 mins. for the system shown in chart 2. Obviously output per hour and per man hour is reduced and the harvester has to wait. If 3 transport units are used with two transport drivers as shown in chart 7 output is again increased to maximum (i.e. the same as chart 2) and output per man hour in this case remains the same and transport waits. If trailers are changed when loads of 2 tons have been obtained output per hour and per man hour fall. This is illustrated in chart 8.

Simulation

It is a just criticism of team balance equations and multiple activity charts that they only deal with average times. However they have a distinct advantage in that they can be compiled very quickly for a variety of situations. The variability in work times for most agricultural situations is well known and if a measure of this variability is used the operational research technique of simulation can be used to find out the effect that these variable times have on output.

One important point which emerges from the consideration of the variability of work times is that balanced systems like those shown on charts 1 and 2 depict closer to optimum than to average. For example a decreased loading time will seldom be exactly matched by a decreased transport time resulting in a faster turnround. However an increased time for any part of the system will result in a slower turnround and thereby reduce outputs.

This paper, whilst not setting out to imply that problems involving labour organisation are simple has by example attempted to show that there are well mapped paths which if followed will assist the farmer in arriving at solutions which will effect worthwhile savings.

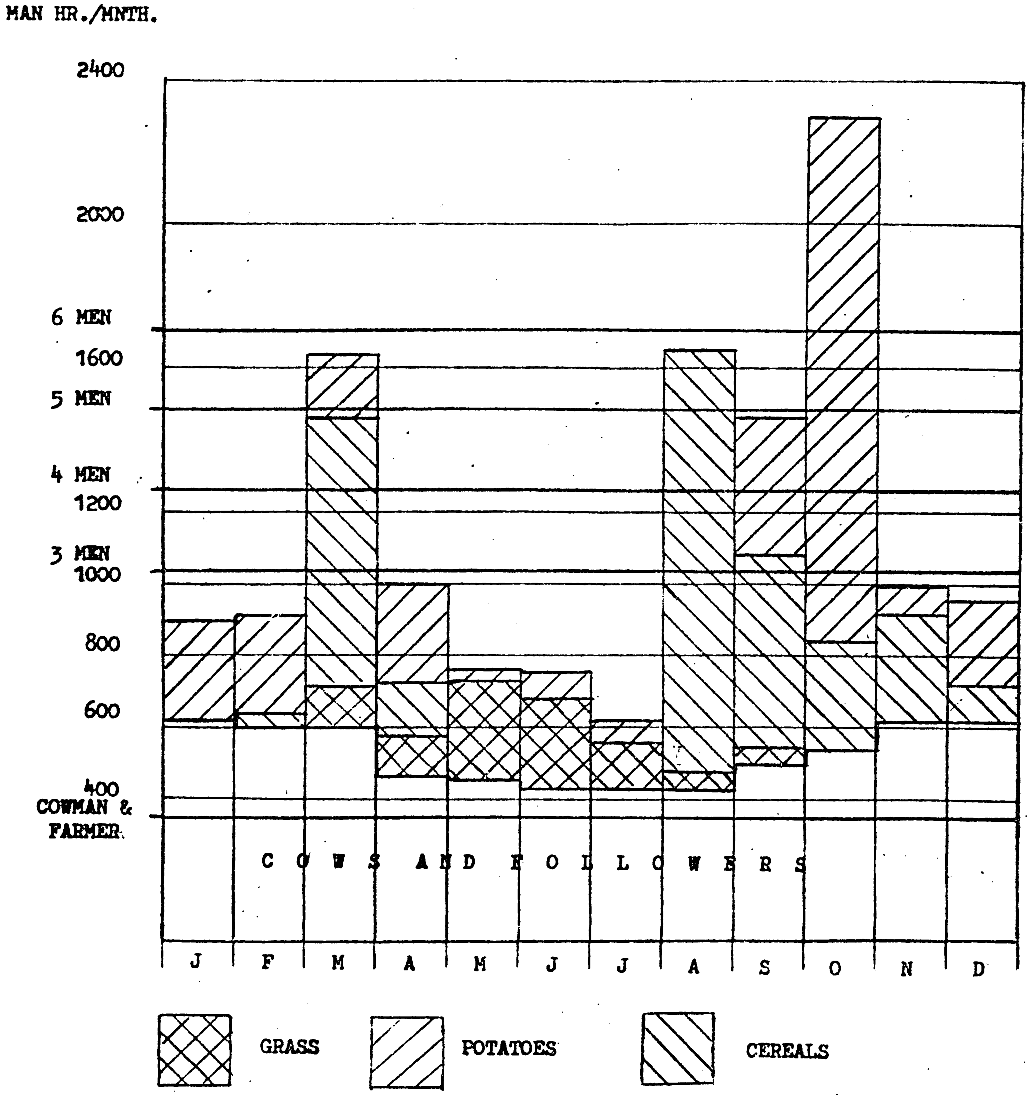

Figure 1 :- LABOUR PROFILE FOR A 495 ACRE FARM (STANDARD MN HR./MNTH.)

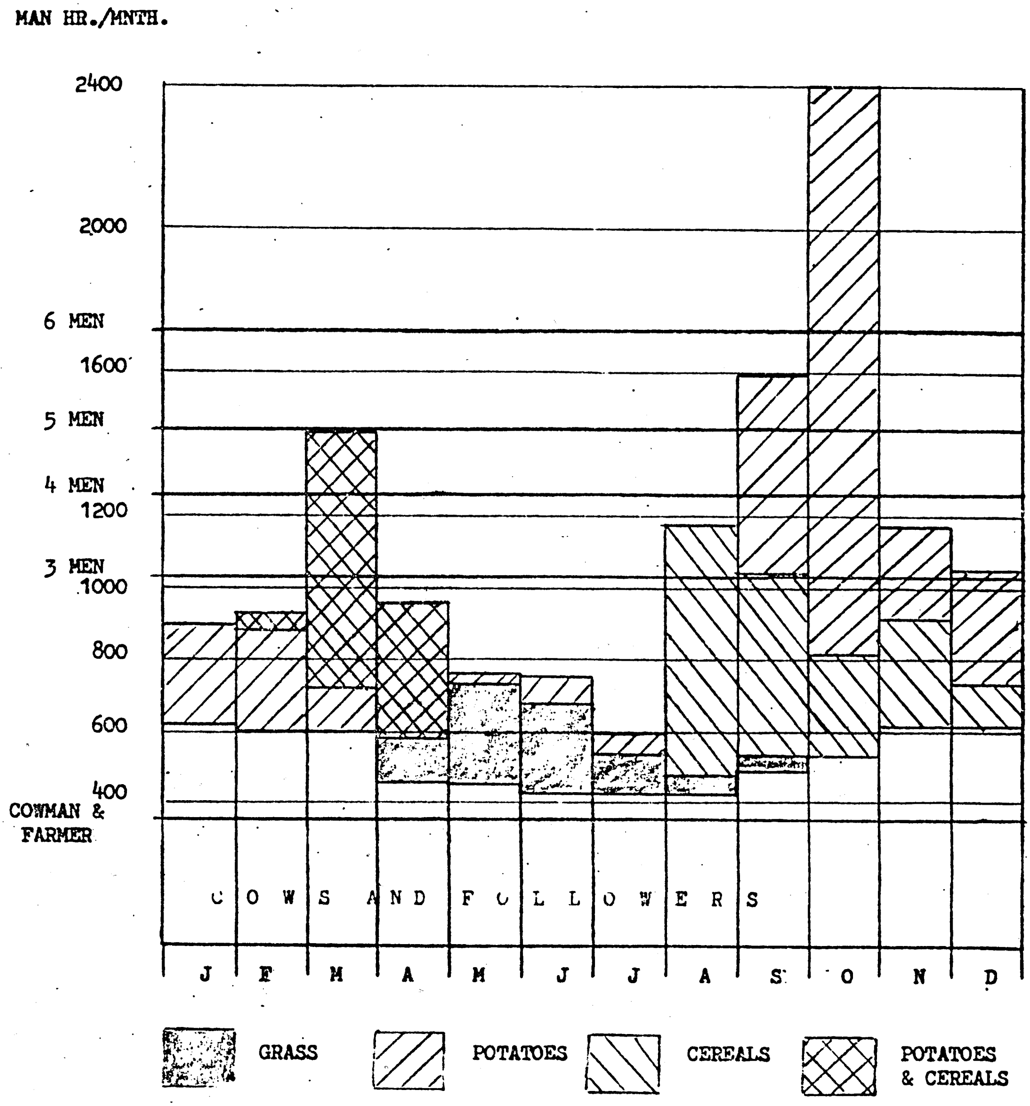

Figure 2 :- LABOUR PROFILE FOR A 495 ACRE FARM (ACTUAL FARM DATA)

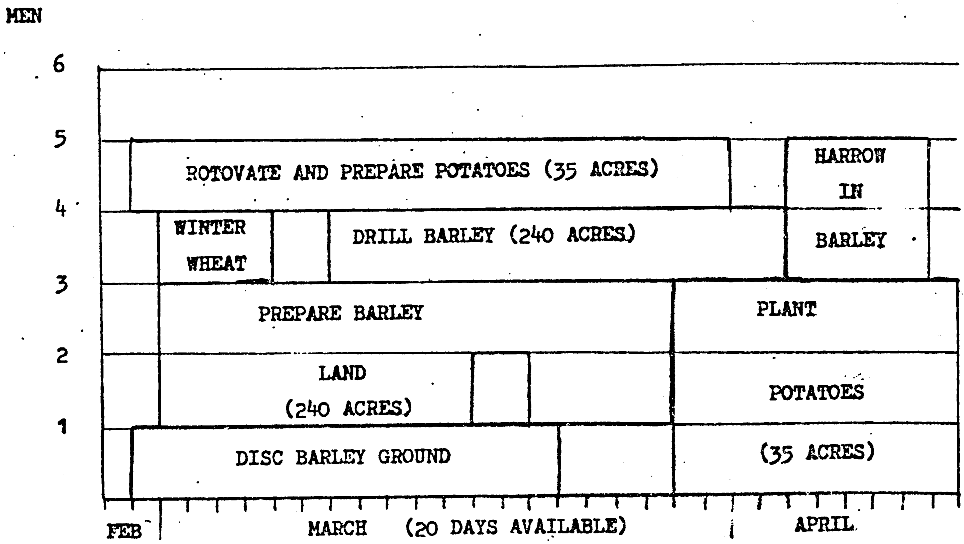

Figure 3 :- GANG WORK DAY PROFILE - SPRING

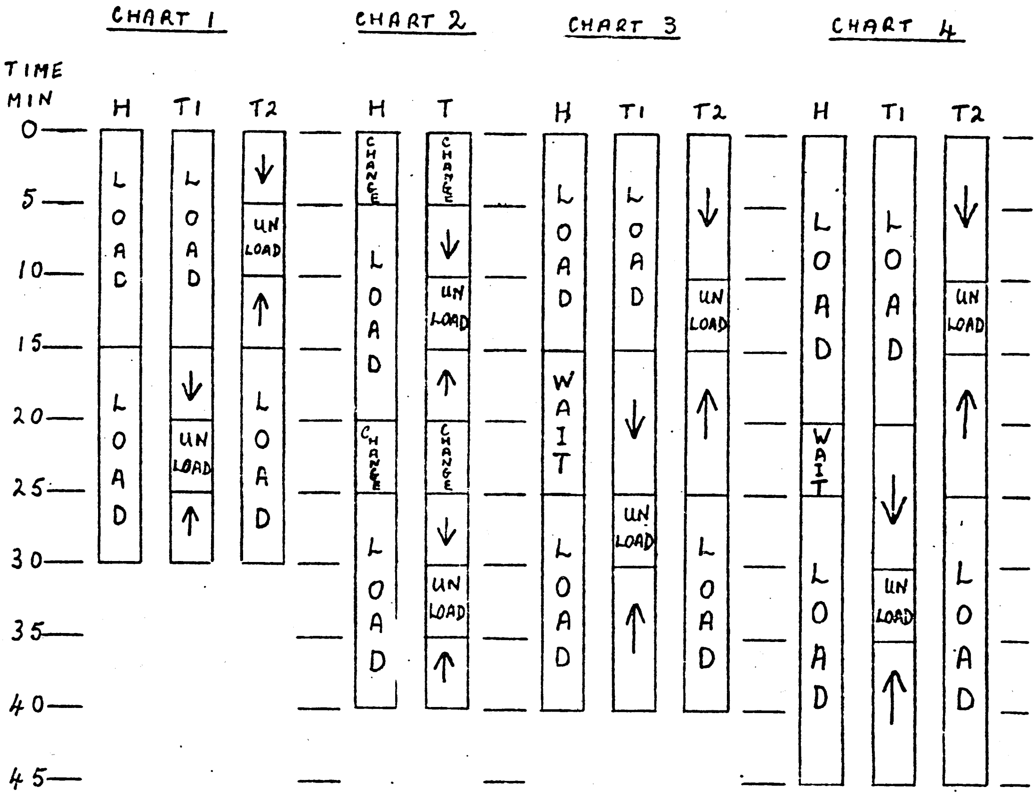

	Chart 1	Chart 2	Chart 3	Chart 4
LOAD WT.	3 TON	3 TON	3 TON	3 TON
OUTPUT PER HOUR	12 TON	9 TON	9 TON	8 TON
OUTPUT PER MAN HR	4 TON	4·5 TON	3 TON	2·7 TON

KEY :- H - Harvester Driver. T - Transport Driver.

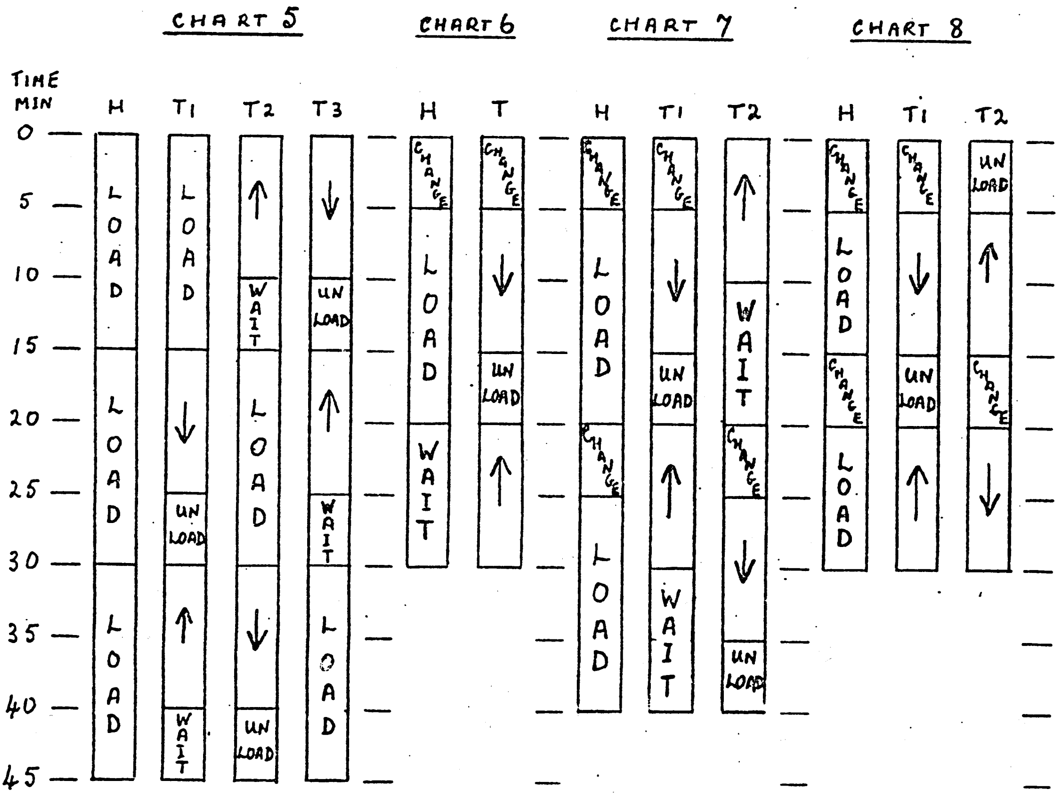

	Chart 5	Chart 6	Chart 7	Chart 8
LOAD WT.	3 TON	3 TON	3 TON	2 TON
OUTPUT PER HOUR	12 TON	6 TON	9 TON	8 TON
OUTPUT PER MAN HR.	3 TON	3 TON	3 TON	2·7 TON

KEY :- H : Harvester Driver. T : Transport Driver.

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March 1970