RESEARCH METHODOLOGY NOTES

COLLECTING INFORMATION ON RATES OF WORK TO EVALUATE THE LABOUR PRODUCTIVITY OF POSSIBLE INNOVATIONS IN OFR/FSP

Several queries have arisen from OFR/FSP practitioners in Eastern and Southern Africa on the evaluation of experiments in terms of labour productivity. With seasonal labour peaks often a factor limiting productivity in African small farm systems it is an important topic. This note attempts point out some difficulties in the use of labour data and to give guidance on sources and methods of collecting rate of work coefficients for operations carried out by labour on small farms. Traditional African Farming Systems which use the hand-hoe as the sole source of power usually experience seasonal labour peaks over the period of land preparation, planting and first weeding. This is particularly true in the 4-7 month unimodal rainfall season characteristic of much of East and Southern African, especially where soil conditions or weed considerations delay the start of land preparation until the onset of rains. Land preparation, in which the soil is inverted by hand hoe, takes between 250-450 labour hours per hectare, depending on soil and water conditions. A typical family using their own labour will necessarily spread this effort over a period of 3-5 weeks. In many situations the first part of the hectare prepared will need weeding before the final part is prepared. It is a period of complex decisions for small farmers using hand hoe as their power source, and with three or four crops to plant. In ox powered systems, in which the ox plough is used solely for land preparation, the effect of relatively rapid cultivation is to concentrate the time of first hand weeding and weeding labour requirements are a common bottleneck. Systems growing teff, rice, cotton or tobacco as a major part of the cropping pattern may experience labour peaks during the harvest period. These crops have high harvest labour requirements. The efficiency of labour use at the seasonal peak fixes family income levels in these labour limited systems. Farmers operating them will use returns to labour at seasonal peaks as a dominant criterion for evaluating recommended innovations. OFR researchers need to use the same criterion in planning and evaluating their experiments.

BEST AVAILABLE COPY

BEST AVAILABLE COPY

PRODUCTIVITY OF SEASONAL LABOUR

There are three approaches to improving the productivity of seasonal labour, each with its own implications for the labour data required in experimental planning and evaluation.

(1) A first approach reduces the labour requirements of the methods being used on operations which contribute to the peak. For example introduce herbicides as a substitute for hand weeding, either on the target crop or on another crop competing for weeding labour.

(2) A second approach is to change the timing of operations, moving some of the demand for labour out of the seasonal peak period. For example 'end of season land preparation' reduces the effort required to prepare a seedbed at the onset of the new rains. Again,'end of the season land preparation' may be used on the target crop itself or another crop demanding labour at the seasonal peak at the onset of rains. Either will reduce seasonal peak labour demands and free up labour to allow better management at the onset of rains.

(3) Finally, improving the yield of a target crop and through this the productivity of the labour employed at the seasonal peak. When yield can be improved by new materials and methods not requiring extra labour

during the peak period, the productivity of seasonal peak labour is also improved.

When improving yield requires extra labour at the seasonal peak period it will only be acceptable to farmers if the yield improvement raises the overall productivity of labour use at that peak time. Returns to the extra labour required for yield improvement must be higher than returns to labour at the seasonal peak in the current farming system. It is important to note that it may be the way the intervention affects labour organisation rather than labour requirements which influences acceptability. For example, where the use of an ox team for ploughing and planting traditionally needs three people, asking families to apply basal before planting the seed may imply a fourth person in the team. Even though the labour requirement per se is very modest, say 2 labour days per hectare, it may be impractical for farmers. The way a new management practice affects labour organisation is an important evaluation criterion as an aspect of system compatibility, and is additional to a quantative economic evaluation. The approach identified as a possible route to improving seasonal labour productivity will dictate the data requirements for prescreening and evaluating the results of experimentation with proposed interventions.

LABOUR DATA - SOME CHARACTERISTIC PROBLEMS

Labour coefficients sometimes desirable for planning and evaluation of experiments in OFR/FSP are for both farmers current husbandry methods and for new husbandry methods implied by the experimental thrusts selected as relevant for target group farmers. In this section three problems of labour data collection and use are discussed and conclusions are drawn on useful sources of data and possible methods of collection.

(1) Specification of Operational Method

There is a need for careful description of the method being used or proposed for used to carry out an operation. For example the length of time it takes to prepare a seedbed will depend on the sequence of operations being used, plough, heavy harrow, light harrow, roll - the sequence needs to be spelled out. Composite operations such as the weeding, thinning and earthing up of maize, and the planting of a bean intercrop, need full description, and, when possible, rates of work attributed to the various components.

(2) Standard Labour Equivalents

Historically labour equivalents have been used as a common denominator to allow the summing, averaging and comparison of household labour forces with different sex and age compositions. These denominators are necessary but generalised ones are unsatisfactory as the relative performance by age and sex varies with the operation concerned and with the community. Farrington (1975) used work study to give empirical labour equivalent values on the main operations of a number of crops. His data on maize rounded to the nearest .05 equivalents are given in Table 1 below for guidance.

Table 1 Efficiency coefficients for various sex and age classes measured for major operations on maize.

Operation	Head house-hold	Adult female in family	Adult male in family	Children (6-15)	Males on piece rates	Males on time rates	Hired female labour
Land pre-paration	1.00	.80	.85	.30	1.20	.85	-
Planting	1.00	.85	.90	.60	.75	.90	.85
Weeding	1.00	.75	.90	.55	1.45	1.10	1.00
Harvesting	1.00	1.00	.75	.60	.85	.90	1.60

(Farrington 1975 rounded to .05)

These coefficients refer to the amount done by the different sex age groups while working including rests while on the job. They do not account for differences in the length of day worked. As we shall see below OFR/FSP does not seek to collect labour data for the whole system. It uses cheap methods to identify seasonal peaks and then may be interested in rates of work for operations contributing to this peak. Where rates of work are of interest coefficients from Farrington's rounded table may be usefully applied for the operations involved, giving labour requirements to allow comparisons and aggregation across households of different sex/age compositions.

(3) Sources of Variation in Labour Coefficients

We have emphasised the importance of careful description of the operation to allow valid comparison and aggregation of coefficients. Nevertheless both the timing of operations, and the rate of work of an operation are vulnerable to three main sources of variation:

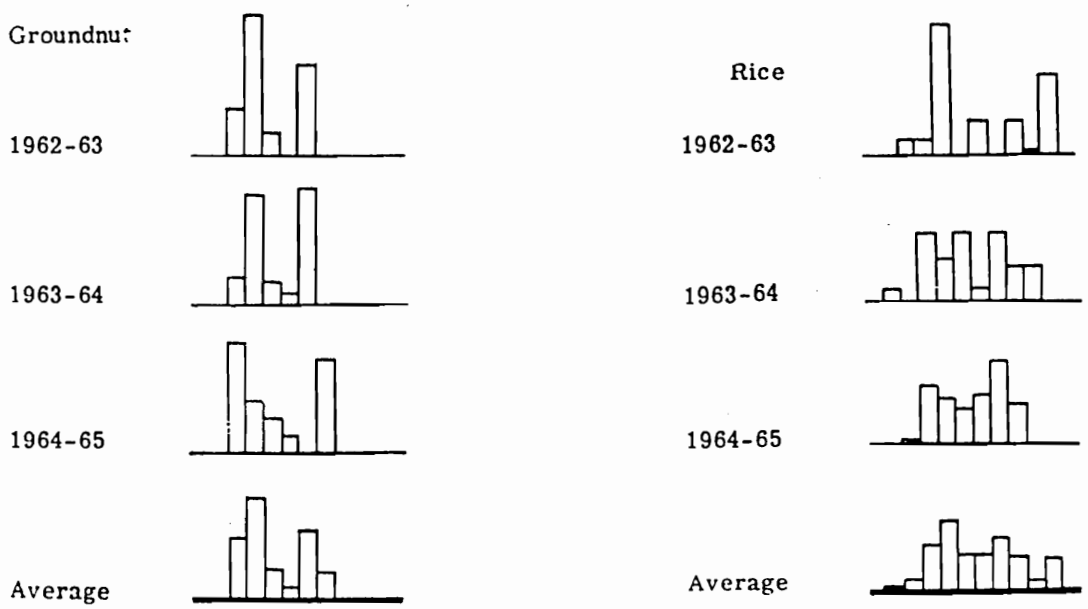
(a) between seasons due to differences in soil and rainfall conditions;

(b) between fields on the same or different farms due to difference in location, cover, and in soil and water conditions at the time the operation is carried out.

(c) between households due to differences in motivation and managerial skills among families.

Probably the most important of these sources of variation is the interseasonal differences in the timing of operations contributing to labour peaks. Figure .1 shows how the labour profiles for the same crops, rice and groundnuts, on the same farm, Ukiriguru Research Station in Tanzania, differed in levels and timing over three consecutive seasons 1962/3, 1963/4 and 1964/5.

Figure .1. A comparison of labour profiles over three seasons.



Collinson (1972)

The key point on variability of labour requirements is illustrated by the averaging of the three profiles in Figure .1. It illustrates the bias arising from aggregation. Due to differences in timing and rates of work, peaks are muted in the averaged profile. Each of the three seasons for both crops shows a higher labour requirement in one period or another than does the averaged profile in any one period. This same type of aggregation bias occurs in averaging across fields where timing is different and also across households in a sample where both timing and rates of work are different.

These three problem areas highlight some of the complexity of collecting and using labour requirement data in planning and evaluating technologies for small farm systems. In particular the difficulties of standardisation of different family compositions and the uncontrollable sources of variation between seasons, households, and fields within and across farms, make precise measurement and the accurate usage of averages a mammoth data collection and analysis task.

In OFR/FSP we are seeking big differences in labour productivity across a group of farmers operating a particular system, perhaps we can say increments of 20% or greater. This gives us latitude in the precision needed in the labour coefficients we use in planning and evaluation. The following guidelines are recommended for OFR/FSP economists:

For initial calculations during pre-screening and for evaluation of experiments in which large differences are observed.

(1) Data from previous labour studies, perhaps done elsewhere can be used as estimates of labour requirements for both current farmer practice, and new methods being introduced in the experiment.

(2) Estimates of the labour requirements involved in their current husbandry practices can be made by farmers operating the system.

If productivity differences are estimated to be relatively small, or, if sensitivity analysis during prescreening shows productivity improvements to be highly dependent on the estimated labour coefficients it will be important to measure labour requirements in the actual local situation during the experimental cycles.

(3) Formal frequent visit survey can give more precise measurements of labour coefficients at relatively high cost.

(4) Formal single visit survey, sampling farmers' experience, can give useful coefficients at relatively low cost.

(5) For labour measurements on new operations being introduced in the course of experimentation, labour inputs can be measured by work study techniques on large trial plots.

THE APPROACH TO IDENTIFYING AND COLLECTING LABOUR DATA REQUIRED IN OFR/FSP

In the context of OFR/FSP both diagnosis and experimentation offer opportunities for the collection of data for calculating labour requirements. During diagnosis the review of secondary data may capture relevant labour coefficients collected elsewhere, the informal survey provides opportunities to obtain farmer estimates and the formal single visit survey can be used to formally sample such farmer estimates. During experimentation, while staff are continually in the area monitoring on farm experiments, any method of labour data collection can be used without significant extra costs.

The approach to diagnosis in OFR/FSP is to obtain an understanding of the whole farming system by the study of secondary information and by informal survey involving discussion with farmers. Once an understanding is gained the diagnostic process is designed to focus with increasing intensity on identified priority problem areas of the farming system. Experiments are designed to solve these problems. In the focussing process whole areas of the system are considered, then cut away and left on one side. This same principle applies to the collection of labour requirement data. Classically farm management surveys have built up a labour profile for the whole farming system. In OFR/FSP only key seasonal labour peaks which will influence and be influenced by proposed interventions to solve priority system problems are of interest. The informal survey rapidly identifies these periods. They can readily confirmed in the formal survey by formatting questions, first to ask farmers and their families which are their busiest months in the year, and second to enumerate the timing and application of labour or machinery hire, which will normally be at these seasonal peaks. Information on the crop and animal operations which contribute to seasonal peaks and full descriptions of the methods used in these operations can readily be obtained and verified in the diagnostic process. In OFR/FSP, in systems where seasonal labour productivity is the main evaluation criterion, decisions are needed towards the end of the informal survey, before the formal survey, on the need for quantative information on labour requirements and how these will be obtained. The remainder of this note looks at the five ways of obtaining labour coefficient information in the context of OFR/FSP.

(1) The use of rate of work coefficients from labour studies done elsewhere

Particularly when major increases in labour productivity can be expected from the introduction of new methods under experimentation, even rough estimates of labour coefficients may be adequate for ex ante budgets during pre-screening, and sometimes for the evaluation of experiments.

There may be other labour studies completed within the farming system being researched. These can be used as estimates if an evaluation of the method used in collection gives confidence that the coefficients, as estimated or measured, are adequate. There are many studies of labour used in African agriculture which may provide adequate estimates. Bearing in mind the need to critically evaluate the conditions under which such studies were done for comparability with the conditions of the system under research. There are three questions to ask when assessing the relevance of rate of work coefficients from other studies.

(a) Are the local OFR team happy with the way the study was conducted?

(b) Are the operational descriptions adequate to judge whether the tools and methods used are similar to the tools and methods used in the system under research?

(c) Are the soil and cover conditions in the area of the study similar to those of the system under research?

References to three sources of labour data are listed below. Farm systems economists should have access to their own sources. They should always be able to bring rate of work information to bear in OFR team discussions on trial planning and evaluation.

- Farm Management Handbook Parts 1&2. Farm Management Section, AGRITEX, P.O. Box 8117, Causeway, HARARE, ZIMBABWE.
- Farm Management Handbook of Kenya. Vol.1. Labour Requirements/Availability. Farm Management Section, MALD, P.O. Box 30028, NAIROBI, KENYA.
- Quarterly Journal of International Agriculture, Vol. 20.2 pp 178 April-June 1981: Labour Requirements in Various Agricultural Systems: H.D.J. Heemst, J.J. Merkelijn and H. van Keulen.

Table .2. extracts information from the Journal reference above.

Table 2. Some estimated labour requirements for African Agriculture.

	Description of operation/crop		Hand hoe	Draught animal
Hours per hectare	Secondary forest	- Single burning and clearing	225	-
	Land preparation	- Turn soil with a digging hoe	300	-
		- Level and break top crust	40	-
		- Plowing with single mouldboard	-	28
	Planting	- Broadcasting	3	-
		- In pre-marked rows plus cover	80	-
		- With ox-seeder	-	7
		- Covering with plough	-	21
		- Rice transplanting	280	-
	Weeding	- First	145	-
		- Second	120	-
		- Third	65	-
		- With ox weeder	-	7
		- Thinning	60	-
Hours per ton	Harvest	- Maize	110	-
		- Groundnut, uprooting in field	195	35
		- Cotton	620	-
	Threshing	- Maize	42	-
		- Groundnut, picking	185	-
		- Groundnut shelling	165	-
		- Cotton grading	570	-

When using such data it is important to categorise operations as 'necessarily timely' and 'postponeable'. It is necessarily timely operations which create seasonal peaks, postponeable operations such as processing and, for some crops, harvesting, can be spread over a period of time.

(2) Farmers estimates of labour requirements

The informal survey allows researchers to make estimates of crop labour requirements for particular operations from a few farmers. Most farmers, especially those operating systems in which labour is a limiting resource, will have their own measures of labour requirements. It will be important for researchers seeking estimates to ask questions which effectively tap the experiences of farmers. For example, few if any small african farmers will be able to answer the question:

> 'How many man-hours does it take your labour force to weed and thin one hectare of cotton?'.

The phrasing takes too much for granted in terms of concepts and definitions. The words underlined in the question reflect concepts which may be completely alien from a local farmers' perspective. They may not think in terms of hectares, nor even have any measure of unit area, in their culture. (Most researchers are more culturally sensitive than this ridiculously phrased question implies, some, unhappily, are not). One well tried approach to getting farmers estimates of labour requirements is listed below:

(a) General informal survey work can readily identify seasonal labour peaks and the crop operations which compete for labour at these peak periods.

(b) General informal survey work can readily describe:

- What each of these operations involves.
- What tools are used and how work is organised for each operation, or each part if a multi-component operation.
- Any age/sex specialisation associated with any of the operations.

(c) Go with the farmer (and/or the appropriate respondent where there is labour specialisation) to a field of the crop which has operations contributing to the labour peak.

(d) At the field ask the farmer the following sequence of questions for each operation of interest for the current seasons crop:

- What date did you start this operation in this field this season? Record week and month. Repeat for the finish of the operation.
- Which family members are usually involved with this operation? Record their sex and age.
- In doing this work do all these family members usually start and finish at the same times of the day? Record the usual daily starting and finishing time for the work group and any exceptions.
- How many days would it usually take these family members, working together, to finish this operation on this field? Refer the respondent to the field in which you and the farmer are standing in and record his estimate in days.

To complete the estimate the size of the field must be estimated or measured by the researcher, perhaps with the farmers help. The labour requirement for each peak operation can be calculated in the following steps.

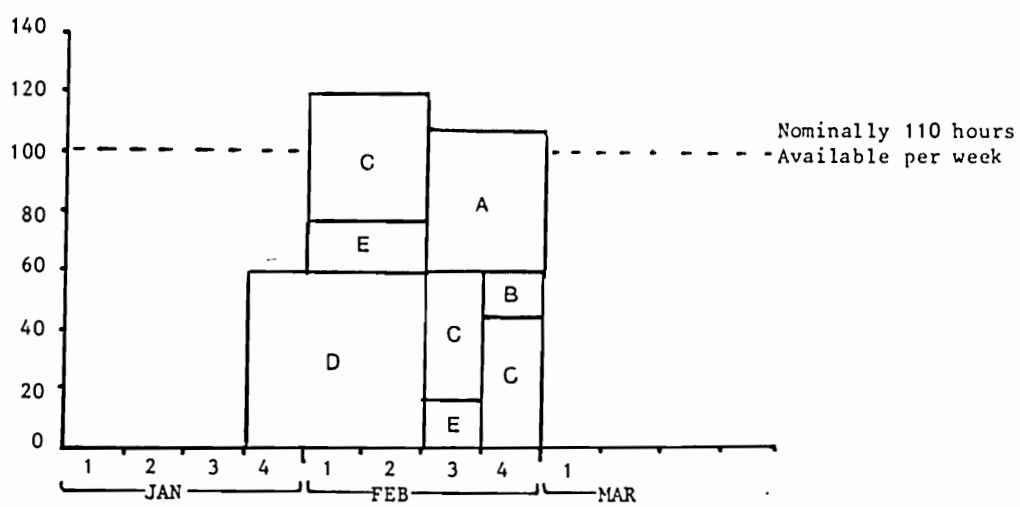
(e)
- Use Farrington coefficients in table .1. to arrive at a man-equivalent value for the group involved in the operation.
- Calculate the number of hours worked per group member per day while involved in the operation. Discount each by the appropriate labour equivalent coefficient.
- Gross up the labour equivalent hours of the group by the estimated number of days taken to complete the field.
- Correct to 'labour hours per hectare' by dividing by the size of the field.

The spread between start and finish dates gives the period over which this labour was applied, and allows the estimation of a 'centre date' for the operation on this farm. Labour hours per ha, the spread of the operation and the centre date are the three 'components' needed to estimate how the operation contributes to the seasonal labour peak. Each contributing operation, an example is shown in Table 3 represents a building block. Put together they give a representation of the seasonal peak, illustrated in Figure .2.

Table 3. Building blocks for estimating seasonal peak labour requirements

Crop	Ha	Code	Operation	Centre Date	Weeks spread	Labour hours/ha
Cotton 1	.80	A	2nd weeding	Feb 20	2	120
Cotton 1	.80	B	Spraying	Feb 25	1	20
Maize 1	1.20	C	1st weeding	Feb 15	4	145
Maize 2	.60	D	Land preparation	Feb 4	3	300
Maize 2	.60	E	Planting	Feb 10	3	80

Figure 2. Estimated seasonal peak labour requirements



The peak period is the first half of February when 119.5 hours per week are being used; 60 hours per week on land preparation for the second maize planting (D), 43.5 hours per week on the first weeding of the first maize planting (C) and 16 hours per week on follow up to land preparation by planting the second plot of maize (E). Once the second maize plot is planted the family labour force begins its second weeding of the cotton plot (A). The second half of February is also a peak with labour being made available above a nominal capacity of the family of 100 hours per week from 2.5 labour equivalents. The seasonal profile assembled from farmer estimates shows the main crops and operations which contribute to the peak It provides a guide for estimates of opportunity costs of shifting family labour to new methods demanding more labour at this time. Researchers can obtain such estimates from a farmer in 1-2 hours depending on the number of crops contributing to the peak, and the distances of fields from farmers homesteads. Labour rate of work coefficients from other studies can be used in this same way, fitting them to the operational and timing details of the calendar of the local farming system. Such estimates are adequate when differences in labour productivity between current practice and proposed new methods are expected to be high, and when measures of peak labour productivity are not unduly sensitive to errors in rate of work estimates. In circumstances in which labour productivity differences are relatively small, or are highly sensitive to differences in labour requirements, more formal, accurate estimation and measurement techniques can be used. This is particularly true for more labour intensive operations with requirements greater than say 30 labour hours per hectare.

(3) Formal, frequent visit surveys

Unless work study - the observation of labour performing operations in the field - is employed, all methods of collecting labour requirements rely on farmer's memory or experience. Formal, frequent visit survey, requires a random sample of target group farmers to be visited every day or every other day, to collect details of work carried out on their farms. In OFR/FSP the technical assistants employed for the day to day management of cluster of on farm experimental sites can have this task built into their work plan for the experimental cycle. In OFR/FSP, the frequent visit routine can be restricted to the seasonal peak labour periods rather than cover all labour activities over the full season. Thus, the costs of collection are not excessive, special staff are not required. For one target group data should be collected from about 40 farms to give adequate precision in the measurement of the average and variation in the labour requirement parameters. It is important that sample farms are visited every other day, and preferably in the evening of the second day so that the farmer and the family are being asked what they did today and yesterday. Past work has demonstrated that observational errors increase rapidly once memories are stretched beyond two days - remembering what work was done the day before yesterday can be difficult. For each farm a sheet should be allocated to each crop plot and each animal enterprise for which labour information is required. On the sheet is recorded the area of plot and the crop, or crops, being grown, or the number and type of animals being managed. Entries are dated and the operation done, the family members and hired workers involved, and the hours they worked during the day are enumerated.

(4) Formal, single visit survey

The technique outlined for obtaining farmers estimates [(2) above] is used on a random sample of farms soon after the peak labour period is past. Farmers are asked the timing of operations for this season from memory, but asked to enumerate the usual work force, working day and work rate for the operation concerned. Responses are sought from his experience with these three components, not his memory. Again about 40 observations are required

to give adequate sample precision to these estimates. A questionnaire is made up with columns for each question set out under (2) above. The interview is done in the field concerned, the sequence of operations is enumerated first, with the timing of each operation. Then the usual work force, work day and work rate is established for the operations one by one. Farmer estimates are more reliable when obtained for a field size typical of the crop in the farming system. Exceptionally small or large fields give distorted estimates.

(5) Work study on large trial plots

Sometimes the new methods being incorporated into experimentation will involve labour operations not found in current farmer practice. Estimates of requirements from labour studies done elsewhere will serve for initial calculations. When there is reason to believe local work rates will be significantly different, work study on large trial plots provides a measure of requirements under local conditions. The primary requirements for useful measurement by work study is relatively large experimental plots so that a reasonable period of work is required to complete the operations involved in the new method of work incorporated in the treatments. The lower the labour requirement for the new operations the larger the trial plot needed to allow reliable measurement. The following guidelines are tentative in the absence of enough experience for analysis. For labour operations requiring less than 30 labour hours per hectare an informed estimate will usually be adequate for planning and evaluation purposes. This would include the banding of fertiliser, all spraying regimes and many planting methods. For moderately labour intensive operations, expected to be from 30-100 labour hours per hectare, plots of about 300 square metres will be needed. For intensive operations, expected to be over 100 labour hours per hectare plots of 150 square metres will suffice. A minimum of 15 observations on replicates at the same or different experimental sites, will give an adequate sample size for a reliable measurement. Labourers are timed over the period to completion of the task, including time at rest on the job. Where two or more treatments have the new operation implemented at the same time it can be measured concurrently across all the relevant treatments in the replicates, and this used as a single observation. In such circumstances the plot size can be reduced pro-rata. More accurate results can be expected if one or two labourers are used for each treatment. Large labour gangs may give distorted figures from these small plots. Where land is not available to handle all the experimental treatments with large plots, or when funds are limited, the experiment can be done with normal plot sizes with a large plot as a satellite treatment for the measurement of labour data. As we have seen the building blocks for a labour profile are; sex/age grouping of the labour, the rate of work, the centre date and the spread of the operation. Work study on trial plots will not provide information on the spread of the operation when done on a field scale. If the operation is judged as necessarily timely, an assumption on the period over which it will normally be spread should be based on local experience of operations with a similar rate of work requirement.

In using labour requirement data remember its variability, particularly in timing and rates of work between seasons. Make an assessment of the typical or atypical nature of the current season and the effects any atypical features might have had on the timing and labour requirements for operations. As demonstrated in Figure .1. inter seasonal variations can radically alter the shape of the labour profile. Estimates of the productivity of labour at seasonal peaks are subject to these variations and any search for the very precise measurement of labour requirements should keep the implications of this variability in mind.

We will be glad to respond to any queries on methods of labour data collection.

M.P. Collinson, April 1986