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MECHANISATION MANAGEMENT : VIEWPOINTS OF THE RESEARCH WORKER [ ].

by

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Without machines the world cannot produce enough food for its millions of people. This is as vital a production means as fertilizer or seed. South African farmers spend R250 million on new tractors and agricultural machinery annually and this figure is continually increasing. Capital investment for machinery on a maize farm in the Delmas district today is about R200/ha for a 600 ha farm. Direct mechanisation costs amount to R80/ha while mechanisation and labour together add up to R100/ha. This certainly makes mechanisation management to every farmer with machinery a very important part of his daily tasks.

I do not propose to refer materially to the planning of labour management, because I understand that other speakers will have dealt with that subject. To handle mechanisation management alone, divorced from the labour aspects, is admittedly to present an incomplete concept because mechanisation and labour are as much a unity as a dovetailed joint, each half being useless without the other. But I am encouraged to concentrate on mechanisation because, after all, every woodworker cuts only one half of the joint at a time and if the two halves are competently constructed, they can be readily mated.

In South African agriculture, mechanisation and labour together are generally responsible for between 50 and 60% of total production costs. However, their relative contributions vary with local conditions and especially with the crop. In apple orchards, for example, about 55% of all costs are incurred by mechanisation plus labour, in approximately equal shares of 27%. But in a survey of wheat production in the Swartland and Rûens areas, mechanisation was found to be 47% and labour only 10% of the total costs. The difference is readily understandable; apple production is difficult to mechanise (and would be very costly), whereas wheat production would be difficult (and also very costly) if only manual labour were used.

Agricultural machinery is becoming larger and more costly, each unit representing a substantial investment. Therefore, to use the equipment efficiently all components of the whole machine system must be matched. If two dogs have to share the same kennel, and one is an Alsatian and the other a dachshund, the opening must be large enough for the Alsatian to get through; but that's not very efficient.

Good mechanisation management is to properly select and match power units and machines. The machines must be carefully suited to the particular farm so that the end result will be the most economical machinery combination possible. Farm mechanisation management therefore is that section of farm management which deals with the optimization of the equipment phases of agricultural production. It is concerned with the efficient selection, operation, preparation, maintenance and replacement of machinery. The essence of business enterprise is economic performance. It follows that the basic function of management is to maximise net profit, and the yardstick for evaluating any decision is the effect it will have on the future net profit of the enterprise.

While it is recognised that many farmers have personal preference and prejudices, or consider comfort and convenience when making machinery management decisions, the researcher cannot accept these factors as valid. The criterion of the researcher is hours of work, normally within the limits of practical working time; although he may also consider day and night operation where the overall cost can be significantly reduced - as, for example, in sprinkler or drip irrigation, or day and night ploughing.

BASIC REQUIREMENTS NEEDED FOR PROPER MECHANISATION MANAGEMENT

What information is needed to do proper mechanisation management?

1. *Operational dates* - The date when a certain operation must commence and when it must be completed must be known. More often a certain operation is dependent on when the rain falls or when it has dried off sufficiently so that the tractor and implement can go into the field, but in planning a mechanisation system we must make

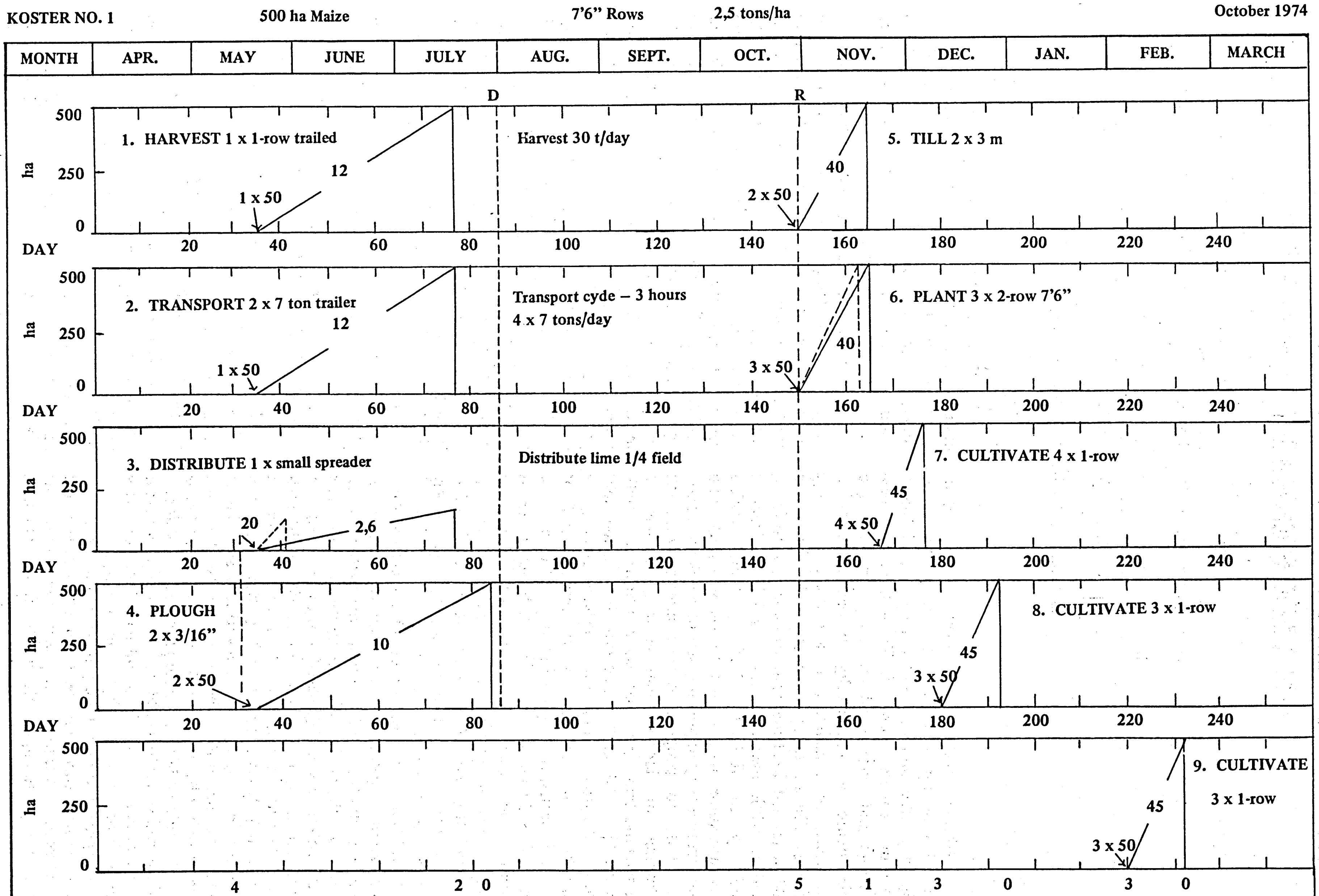

FIG. 1 - Activity chart

certain assumptions of the dates when these are most likely to occur. These assumptions enable us to know exactly how much time is available for each operation.

2. *The rate of work* - With the total time for each operation and the area to be cultivated known it is possible to establish the rate at which the work should be done. At this stage it is important to allow for down time due to poor weather conditions, allow for machine breakages and circumstances which may mean that the total operation will take a little more time than the theoretical rate.

$$\text{Rate in km/h} = \frac{\text{width (m)} \times \text{speed (km/h)}}{10} \times \text{efficiency factor}$$

3. *Fit the machines according to the rate of work for each operation* - Using the rate at which the work must be done it is possible to establish the capacity of the machine to be used. It must now be decided whether one machine or more are needed to do the work. Complete all the operations on an activity chart indicating the rate of work and the dates when operations start and stop. Indicate also the machines being selected to do the work. (See Fig. 1.)

4. Calculate the cost for each machine as well as the total for all machines and operations. (Table 1.)

5. Introduce alternative systems to do the same work and repeat the cost calculation for each alternative system.

6. The possibility of cultivation practices using reduced operations may also be considered and completely calculated as another alternative.

7. Summarize all the alternatives with respect to machinery and labour costs for the complete system and then make a decision as to whether which one is more feasible from a practical point of view, from a management point of view as well as from a cost point of view (Table 2). This will enable the manager of the farm to make a decision which will suit his particular farm the best. It must be realised that to come up with the best plan several alternatives must be considered and completely worked out. This means that quite a few calculations need to be done, making this quite a time-consuming task. Certain researchers have developed computer programmes to assist and overcome this problem of making calculations and comparing alternatives. This enabled them to come up with a much easier and quicker solution to this problem.

8. With all the calculations and systems available it is still necessary to implement this in practice and after it has been implemented, to compare the theoretical calculations with the operations of the machine plus operator. Only by doing this is it possible to weigh the assumptions made in respect of the capacities of the machines in order to determine whether these values were realistically chosen in respect of the machines as well as operators and the conditions under which they work. We all know that there will be variations from one season to another, climatic conditions will change and rain will not fall on the same day every year. During one season it rains more than in another. One year it will be a problem to cultivate the lands because of insufficient rain, the next year too much rain will have fallen and it will be a problem to get into the lands to cultivate them at all. Variations like these make it very difficult to come up with a good assumption which will fit planning every time. A normal rule of thumb often used in research is to make use of an assumption which will fit the plan 80% of the time.

9. The replacement or leasing of machinery is an important part which must be fed into the system as a basic policy. In other words, before starting mechanisation planning it is necessary to make a calculation of what the leasing or renting of machines will cost and after what period machines should be replaced to give the lowest cost figure.

TABLE 1 - Cost per machine as well as total cost for all operations

Farm: Koster I; Hectare: 500; Crop: M 7'6"; Yield: 2,5 t/h; Date:

Operation	Implement	Number	Price each	Price total	Depreciation		Operation time			Power			Other costs	Labourers	Drivers	Remarks 20 km, medium-terrain
					%	Amount	Days	h/day	Total hours	kW nominal	kW corrected	kW-h				
Harvest	1-row trailed	1	7 410	7 410	20	1 482	42	10	420	50	40	16 800		2	1	
Transport	7 t trailers	2	2 900	5 800	5	290	42	10	420	50			400		1	0,1 ℓ/ton km 250 ℓ @ 16c
Spreader	600 kg	1	650	650	5	33	6	10	60	50	28	1 680		2		
Plough	3x400 mm	2	265	530	5	27	50	10	500	100	80	40 000			2	
Till	3 m	2	610	1 220	5	61	12	10	120	100	80	9 600			2	
Plant	2-row 2,3 m	3	3 450	10 350	10	1 035	11	10	110	150	66	7 260		3	3	
Cultivator	1 row	4	400	1 600	5	80	11	10	110	200	72	7 920			4	
Cultivator		3					11	10	110	150	87	9 570				
Cultivator		3					11	10	110	150	87	9 570				
Tractor	50 kW	5	10 600	5 300	10	5 300										
				80 560		8 308						102 400	400	4	9	
				A		B						C	D	E	F	

TABLE 2 - Comparison of systems

Koster

System	I	II	III	IV	V
ha	**500**	**500**	**500**	**1 500**	**1 500**
Running costs					
Interest	4 028	4 540	3 158	9 484	7 350
Repair and maintenance	8 056	9 080	6 317	18 968	14 701
Depreciation	8 308	11 513	6 183	10 604	17 588
Labourers	2 000	2 000	3 000	5 000	1 500
Drivers	5 400	1 800	3 000	8 400	1 800
Fuel	5 069	3 642	4 299	15 175	9 270
Contract	-	-	-	-	10 714
Total running costs	32 861	32 575	25 957	67 631	62 923
Capital investment	80 560	90 803	63 170	189 680	147 010
Number of tractors	5	1	2	11	2
Number SP combines		1			1
Total units	5	2	2	11	3
Total operational days	232	152	222	235	246
Management load*	2,16	0,66	0,90	4,68	1,22
Capital investment R/ha	161,12	181,61	126,34	126,45	98,01
Running costs R/ha	65,72	65,15	51,91	45,09	41,95
Running costs R/ton	26,29	26,06	20,77	18,03	16,78

$$*\text{Management load} = \frac{\text{Number of power units} \times 100}{\text{total operational days}}$$

This must then be fed into the planning. Again only complete systems must be compared and not only a specific part of such a system.

There are still some problems encountered by researchers in South Africa and overseas on mechanisation management. Most of these problems can be regarded as due to insufficient information being available. For proper mechanisation management, information with regard to machine performance in terms of capacities, power requirements and labour requirements must be available. Information with regard to the cost must also be known. Let us briefly discuss the kind of information required in a little more detail.

CAPACITIES

In all mechanisation planning programmes it is important to know what the capacity of a machine is to establish exactly the size of the required machine and the power requirements. In order to make a calculation it is necessary to have a reliable figure of the capacity of a machine under specific conditions. Normally calculations are based on actual measurements in the field, but it must be remembered that ploughing is not always done on the same day and conditions vary throughout the season. What one machine achieves on a particular day may only be true for that day but a week or a month later it may be completely different. Power requirements vary and ploughing a field in July may be completely different from ploughing it in October. The same applies to cultivating land in the North-Western Free State as compared to the Northern or Eastern Transvaal. The same power requirements or capacities cannot be assumed for the different soils, even if the same tractor and implement are working at the same depth. It must therefore be remembered that using an average value in these calculations makes it vulnerable to mistakes. Even using different values for different soil types is not sufficient. It depends on the time of the year a particular operation is carried out.

Various values of the power requirements for tractors and implements, the speed of operation and possible capacities achievable have been measured in various parts of the country. These values still only apply for the conditions under which they were fixed. The same problems occur in the USA except that their conditions do not vary to the same extent as in South Africa. Normally moisture is not such a limiting factor when the soil must be tilled. Usually they have too much rain in spring and have to wait until the fields have dried to the extent where they can start planting. But they still have the differences in soils which means that the power requirements will change when going from one soil type to another.

TILLAGE PRACTICES

In most cases where mechanisation management has been planned and put into operation in South Africa it was done by using the normal practice as applied in that particular area. In other words, if a farmer was practising a conventional tillage method the new system or alternative being considered would use exactly the same operations. While machinery management programming lends itself ideally to suggest different tillage practices, this is a decision which the farmer must take upon himself, based on agronomic research results. This kind of change in a tillage practice can only be recommended by researchers in the field of agronomy once they know exactly what can be achieved in a particular region. It has always been realised that a simpler and in certain cases a much cheaper machinery system is possible, especially when thinking in terms of reduced or no tillage practices, provided this change-over has been well-proven. Various research workers, particularly in the USA, have already pointed out that when a system is planned where the number of machine operations are reduced and costs brought down pro rata, the application and cost of weed killers normally increase markedly. If these practices are compared with the conventional systems it is most likely that the total cost will cancel the saving.

The farmer must also bear in mind that when he changes to a completely new system his management requirements also change and may place the emphasis on a completely different place.

TIMELINESS

This is a factor which is very important to bear in mind in all mechanisation management studies. Timeliness in mechanisation management means that a particular machine must have sufficient capacity to complete the operation in time and thereby ensure that the maximum yield will be obtained. If we have insufficient capacity it may mean that the operation will not be completed in time and that there will be a reduction in yield. In mechanisation planning timeliness can be debited as a cost against a particular machine system if the system does not have adequate capacity to complete the operations in time. This is a very important factor but it is also directly dependent on many other factors like the crop under cultivation, climatic conditions and what is to be considered the maximum yield under these conditions. We do not always have enough information available to take these timeliness costs into account. Quite often the final planting date for certain crops to obtain the maximum yield is not known or the percentage with which the machinery should be penalised for each day that this date is not reached, can lack. More research should still be done to obtain this information in respect of each crop, especially to know what the aim date is in order to obtain the maximum yield. Only with this information is it possible for the researcher to calculate the optimum machinery requirements.

Particularly in the USA agronomists have succeeded in providing valuable information on crop production losses for each day a crop has been planted after the latest planting date.

TRADITIONS

It has long been realised that tradition plays a significant part in all agriculture. Mechanisation in this respect has never been an exception. Farmers tend to think that operations on the farm can only be done with a certain size implement and pulled by a certain size tractor at a certain speed. Engineers have long been trying to indicate to farmers that they may be using their equipment at a very low efficiency. In particular it is known that farmers tend to do their ploughing operation in too low a gear and at too slow a speed of about 4 to 5 km per hour although modern day tractors give maximum efficiency at 7 and 8 km per hour. Farmers do not realize that they are wasting power when their tractors operate with a wheel slip of over 20%. These are factors which directly affect efficiency and as a result of which it is probably necessary to work an hour longer per day. It may mean that the planting operation can be finished a day or two earlier, using less fuel and with less tyre wear.

SUMMARY

In general this can be described as planned mechanisation management. When more crops per year are introduced like irrigation lands the same procedure applies but it may make the planning more difficult. Once planned, however, it will certainly make the overall management much easier.

For our day and time it is essential that mechanisation management be properly planned on every farm. With this information at hand, the farmer can easily introduce an alternative system to cut down costs and overcome to a large extent the increasing costs of machinery.

In short, mechanisation management must be very well planned.

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