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**Economic Aspects
of Mechanization
on Medium-sized
Farms**



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By G. KREHER

Institut für landwirtschaftliche Arbeitswissenschaft und Landtechnik, Bad Kreuznach

ECONOMIC ADVANTAGES OF MECHANIZATION ON PEASANT FARMS

IF the accounts of different farms are examined in an attempt to calculate the influence of mechanization on net profit (or labour productivity) no clear relationship can be established. It is not simply a matter of a rise or a fall in net profit following increased mechanization. Much more decisive for the success or failure of mechanization is the ability of the manager. The kind and suitability of mechanization is much more important than its intensity. Unfortunately the ledger accounts for machinery do not give any information in this respect. The question of the economic advantages of mechanization, therefore, will be answered here not by the inductive but by the deductive method (with labour budgets)¹ which makes it possible to keep the performance of the manager and his staff constant (at an adequate level) for all the stages of mechanization to be investigated.

Under what conditions should the purchase of a machine be considered if it is to be economic?

1. The machine works more cheaply than the corresponding human and animal power.
2. Scarcity of regular and casual labour (*AK*) compels the use of a machine even when it costs more than manpower.
3. The machine improves the quality of work.
4. The machine makes work easier.

If any one of these four conditions applies, the purchase of a machine can be considered. In the fourth case the machine is bought simply to ease work (e.g. a manure distributor) and the matter is decided by physiological reasons. But in the first three cases the decision rests on economic grounds and the question arises how the economic calculations have to be made.

As regards machines which serve to improve the quality of work, the money value of the increased yield has to be placed against the

¹ G. Kreher, *Der Arbeitsvoranschlag im Bauernhof*. Obtainable through KTL, Frankfurt/M. Eschersheimer Landstr. 10, or Studiengesellschaft für landw. Arbeitswirtschaft, Bad Kreuznach, Kauzenberg.

cost of the machine. The lengthiest part of this procedure is the ascertaining of the increased yield, which can only be gathered from investigations lasting several years. As this case occurs less frequently and the manner of calculating the economic advantages is obvious, it need not be examined further here.

In the case of machines which are destined to save labour, total labour costs with the machine have to be compared with those without the machine. The process with the lowest labour costs will have preference so long as there remains a free choice between human labour and machinery. Should the number of workers, however, fall to such an extent that the machine becomes essential for doing the farm's operations—even though the machine operates more expensively than human labour—then a reduction of net profit must be accepted. Mechanization is justified so long as the net profit decreases less with the use of a machine than from cultivating at a less intensive level. Where there is a scarcity of labour, therefore, the criterion is not the process with the lowest cost but that which with a small amount of labour (*AK*) still enables the most economic organization of the farm. This organization can be ascertained only through complete budgeting, i.e. the placing against one another of all receipts and expenses. In this respect, the most difficult task is to ascertain labour costs. The remaining expenses may be entered by reference to the previous years' accounts while the quantities sold and the prices realized can be readily calculated by the use of the *Wirtschaftsrahmens* (tables of average yields and average prices forming a framework for budgeting), for the different types of farm organization.¹ Summing up, therefore, with regard to the use of labour-saving machinery, the criterion in the case of a large enough labour force is the lowest labour cost and in the case of shortage of human labour that type of farm organization which is still economic. In the first case labour budgets are sufficient but in the second complete farm budgets are necessary. In the labour budget according to the *Zeitspannenverfahren* (subdivision of seasons into periods) and in the *Wirtschaftsrahmen*, techniques have been evolved in our Institute which are suitable for labour and farm budgeting generally. It is the task of this paper to describe labour budgeting for different stages of mechanization, by which the purchase of a machine can either be judged immediately or the preliminary stage for a complete farm budget be made possible.

¹ Preuschen-Rheinwald-Glasow, *Der Wirtschaftsrahmen*, 2nd edition by Blechstein in the press.

In the labour budget according to the *Zeitspannenverfahren*, the whole period of field work (from the beginning of spring cultivation up to the onset of sustained winter frosts) is the basis for the calculation of the labour force, draught power (*ZK*) and necessary quantities of machinery. The whole period of field work is then divided between the different field tasks, and those with equal or consecutive periods are put together in 'blocks'. In these blocks the labour requirement for each task is calculated by multiplying the acreage by the requirement per hectare (the latter based on labour studies). The sum of the labour requirements for all field tasks in a single block divided by the available working days in the block gives the daily necessary labour and draught power hours in the period. In order to ascertain the labour requirement for livestock, their numbers are multiplied by the corresponding daily requirement standard. The labour requirement for indoor work is added to that of each block in order to arrive at the labour requirements of the farm during the various times of the year.

Work estimates for a *peasant holding with two-horse team* (approximately 10–20 ha.), 49 per cent. cereals, 21 per cent. roots (16.8 per cent. potatoes, 4.2 per cent. fodder beet), and 30 per cent. forage, are shown in Fig. 1. Livestock numbers per 100 ha. are 65 cow units (30 cows, 22 young stock, 14 horses, 100 pigs). In order to make comparison easy the requirement figures for each block in the graph are based on 100 ha. The horizontal lines in the blocks give the labour requirement for various stages of mechanization. The fall in labour requirement with increasing mechanization can be read on the manual labour part (the upper part) of Fig. 1 by means of the horizontal lines, while on the draught power half the simultaneous rise in *ZK* requirement can be seen. The following three stages of mechanization were assumed:

1. *Stage with hand labour prevailing*

Cultivation with team, hand sowing, hand planting of beet, potato cultivation with *Markör* and single-shared ridge-plough, hay and cereal harvest with scythe, potato digging by hand, potato sorting by hand, steel-tired cart.

2. *Stage with simple draught power*

This stage is characterized by drilling machine, cultivator, horserake and tedder for hay harvest, mower with hand release for cereal harvest, potato spinner, potato-sorting machine, and steel-tired cart.

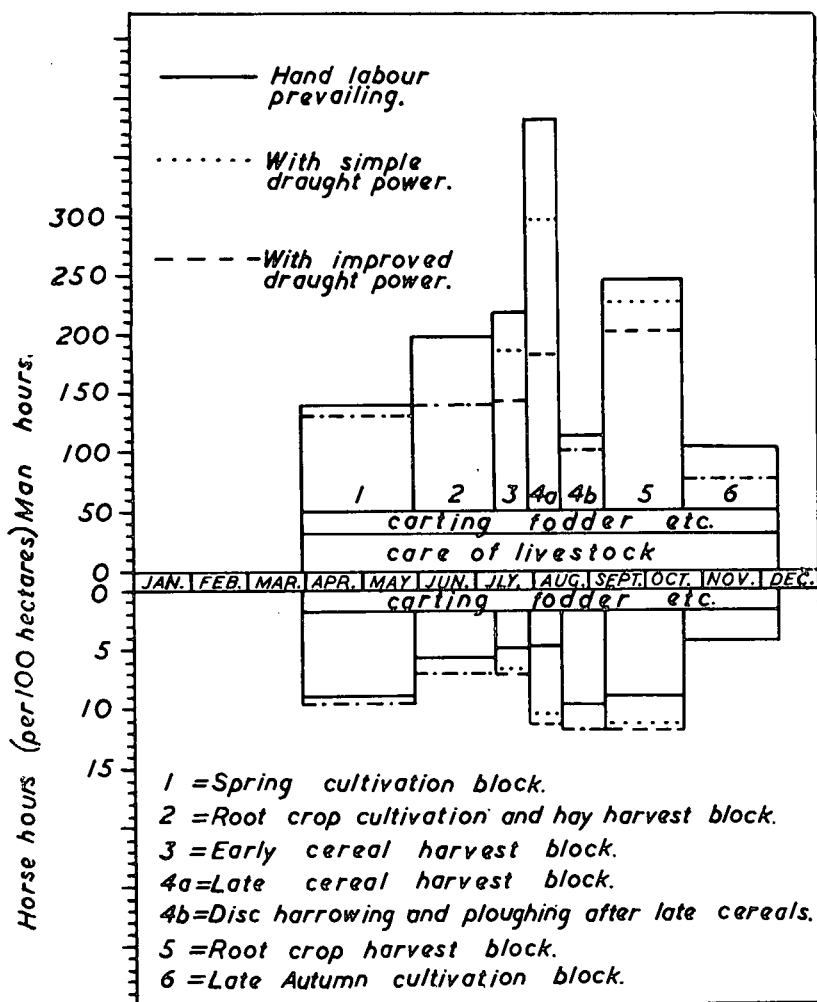
LABOUR BUDGET

FIGURE 1

3. Stage with improved draught power¹

In addition to the machines of the second stage, this stage has binder and potato harvester.

Three stages of mechanization appear, therefore, in the cereal- and root-harvest block; in all other blocks two stages. The labour

¹ The findings for this stage correspond approximately with those of the partially motorized stage (team and tractor) on European mixed farms.

requirement in each block varies with increasing mechanization in the following percentages:

Spring cultivation	AK from 100 to 94
	ZK „ 100 „ 108
Root cultivation—hay harvest	AK „ 100 „ 71
	ZK „ 100 „ 121
Early cereal harvest (winter barley and winter rape	AK „ 100 „ 85 to 66
	ZK „ 100 „ 133 „ 141
Late cereal harvest	AK „ 100 „ 78 „ 48
	ZK „ 100 „ 281 „ 306
Disk harrowing and ploughing after late cereals	AK „ 100 „ 92
	ZK „ 100 „ 130
Root crop harvest, winter cultivation	AK „ 100 „ 93 „ 83
	ZK „ 100 „ 124 „ 130
Late autumn cultivations	AK „ 100 „ 76

The saving of labour is greatest for stages 1-3 in the late cereal harvest block, the man hours (*AKh*) of which fall by 52 per cent. The early cereal harvest follows with 34 per cent. and the root cultivation-hay harvest with 29 per cent. labour saving. An equally large saving of labour cannot be achieved in the root-harvest block. With the decrease in man hours an increase in draught-power hours runs hand in hand. The outer line of the blocks represents the *ZK* requirements in the improved draught-power stage. The greatest saving on the *AK* part is matched by the greatest increase on the *ZK* part: the *ZK* requirement increases in the cereal-harvest blocks by around 41 per cent. and 206 per cent. respectively. The root harvest follows with an increase of 30 per cent.

In order to ascertain the effect of these block results on the labour requirement of a farm, it is not sufficient just to calculate the average for, or the sum of all the blocks—for it is quite possible for the saving of labour to have absolutely no effect on the *AK* requirement of a farm; such is the case when savings are effected in 'the labour trough' of the year. It is useless to employ labour-saving machinery at a time of year when the regular labour force can comfortably cope with the work. This only burdens the farm with additional machinery costs. The criteria are, therefore, the basic *AK* and *ZK* requirements during the whole course of the year's work. These are calculated below for the three stages of mechanization related to the usual unit of 100 ha. (*LN*). In doing this it is assumed that, for the cereal and root harvest,

casual workers are available and that the next highest block (root-crop cultivation and hay harvest) determines the regular *AK*. As daily working time, the usual time still prevailing on German peasant farms during the summer half-year is taken—although this should be reduced as a matter of urgency on physiological grounds. This amounts, for regular *AK*, to 12 hours, and for casual *AK* to 10 hours. The daily working time for *ZK* is assumed to be 9 hours. Here the highest peak determines the *ZK* requirement as generally casual draught power is not available. The *AK* and *ZK* requirements per 100 ha. vary in the three stages of mechanization as follows:

	<i>Labour force (AK) requirement</i>				<i>Draught-power (ZK) requirement</i>	
	<i>Regular AK</i>	<i>Casual AK-days</i>	<i>Total AK</i>	<i>%</i>	<i>Horse numbers</i>	<i>%</i>
1st stage	16.6	424	18	100	10.1	100
2nd stage	11.8	536	13.6	75	12.6	125
3rd stage	11.8	246	12.6	70	13.2	131

The percentages move almost equally for the *AK* decrease and the *ZK* increase. Particularly large is the *AK* decrease from hand labour to simple draught power. From there to the improved draught-power stage only a further 5 per cent. labour-saving is obtainable on the farms investigated.

After the *AK* and *ZK* requirements in the three stages have been established, their costs have to be ascertained. The following costs are assumed: Regular *AK* = 3,000 DM./year, 1 casual *AK*/day = 10 DM., and one average horse = 1,200 DM./year. A simplified solution can be found for dealing with the varying machinery costs. The costs of machinery for stage 1 will not be calculated since they also appear more or less in stages 2 and 3. Only the additional machinery costs for stages 2 and 3 are included (amortization, interest, and repairs). The latter vary with the size of the farm, so that they are calculated for a two-horse farm of between 10 and 20 ha. (Fig. 2). With regard to draught power it is assumed that there is a complete correspondence of type of horse (light, medium, heavy) with the individual *ZK* requirement. For stage 1 the labour costs per hectare *LN* remain constant as no machinery costs occur. In stages 2 and 3 labour costs vary with the different additional cost of machinery per hectare *LN*. At the present price-wage relationship in Germany, the lowest labour costs for the farms investigated occur at the simple

draught-power stage. Lower labour costs are first achieved at the improved draught-power stage only on farms (of similar types) of over 30 ha. It is true that in cases of joint ownership of binder and potato harvester their use becomes economic considerably earlier.

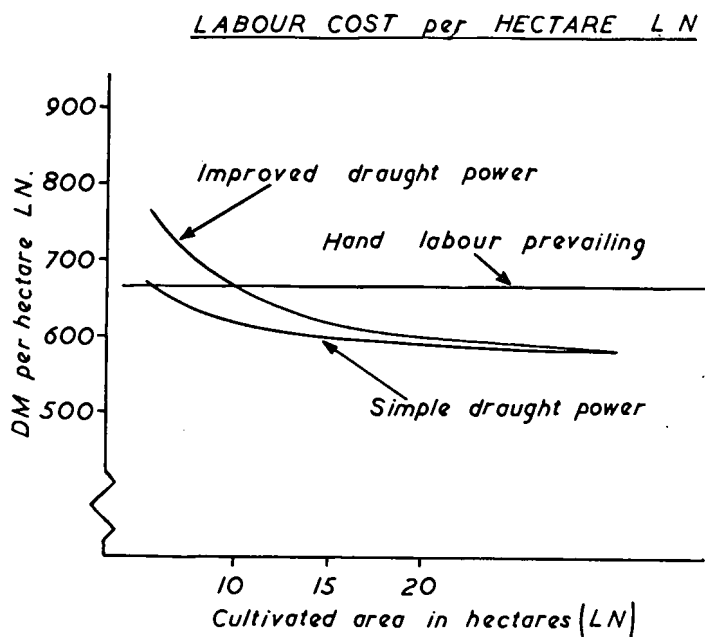


FIGURE 2

As already mentioned, the labour requirements of the partially motorized stage correspond approximately to those of the improved draught-power stage. In the Federal territory there are only a very few fully mechanized farms. At the present time labour studies are being carried out in order to determine the effects of this stage of mechanization on the labour requirements for all field work. On the conclusion of these investigations it will be possible to calculate labour estimates and labour costs also for this stage.

Summary

The economic advantages of mechanization are dealt with here by the deductive method—with the aid of labour budgets. The latter allow labour and draught-power requirements to be calculated for every variation in acreage, livestock numbers, and mechanization. For average acreage and livestock numbers, mechanization is varied for

farms of from 10 to 20 ha. From the simplest stage which still relies on heavy manual labour, up to the improved draught-power stage, a 30 per cent. saving is achieved in AK requirement against a 31 per cent. increase in ZK requirement. The lowest labour costs (AK , ZK , machinery) are achieved on the farms investigated (under the present price-wage relationship) at the simple draught-power stage. If sufficient labour is available it is unnecessary to go beyond this stage. Only with a scarcity of casual labour has increased mechanization to be considered, namely when machinery costs cause a smaller decline in net profit than would be caused by cultivating at a less intensive level. For such a decision to be made, complete farm budgets are essential.