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



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A REVIEW OF DEVELOPMENTS IN MECHANIZATION IN SOME EUROPEAN COUNTRIES

Use of census data

MANY of the problems of the economics of mechanization in agriculture must be studied on individual farms, with full regard for human and other factors which do not readily submit to measurement. It is possible, however, by the use of census material to study in broad outline how mechanization develops. Most European countries have taken censuses of farm machinery in recent years, and a number of analyses by size and type of farm have been published. The censuses were held at various dates and in analysing the results the different countries have not always used the same size-groupings. Nevertheless, the statistics show that certain features recur in a number of countries.

Farm mechanization is something more than 'motorization', or the use of tractors in place of animal power. The following analysis deals mainly with tractors and horses, but for a more complete account it would be necessary (though the material is not always available) to deal in a similar way with milking machines, dairying equipment, electric and oil engines installed in barns and other farm buildings, motor lorries, cars, &c. The character of mechanization varies with size of farm; on the smaller farms a greater proportion of the work is done in and around the farm buildings.

Tractors and horses

In fourteen countries of western Europe there were nearly one million tractors at the end of 1951. The number was increasing at the rate of 15 per cent. a year. Horses, which outnumbered tractors by 8 to 1, were declining at the rate of 5 per cent. a year between 1951 and 1952 and this rate was increasing (Table 1).

The United States and the United Kingdom are among the countries which have reached a relatively advanced stage of mechanization. This year they will have more tractors than horses. Tractor numbers are still increasing but at a slower rate than in most European countries. Horses in the U.S.A. and the United Kingdom are declining much more rapidly than elsewhere.

TABLE I. *Numbers of tractors and horses in some European countries and in the United States, 1949 to 1951 (and 1952 for horses)*

	Tractors (000)			Horses (000)			
	1949	1950	1951	1949	1950	1951	1952
Austria . . .	11.1	13.9	17.9	284(a)	282(a)	283(a)	276(a)
Belgium . . .	(7.0)	9.7	(12.0)	267	266	249	223
Denmark . . .	12.3	17.9	25.2	532	502	465	423
Finland . . .	10.2	12.3	17.3	402	400	(398)	(396)
France . . .	122.6	138.7	153.3	2,414	2,397	2,380	2,333
Germany, West . .	109.8	139.0	184.5	1,617(a)	1,629(a)	1,570(a)	1,455(a)
Ireland . . .	10.1	12.9	15.4	402	391	367	342
Italy . . .	50.6	56.9	66.4	798	797	768	750
Luxembourg . . .	0.7	1.0	2.0	16	15	14	14
Netherlands . . .	16.0	18.4	22.0	276	252	250	241
Norway . . .	9.5	11.0	12.0	198	191	184	175
Sweden . . .	57.8	68.4	77.4	465	440	415	386
Switzerland . . .	16.7	17.5	19.7	138	134	131	131
United Kingdom . .	308.4	325.0	342.1	618	549	478	414
Total, 14 countries	742.8	842.6	967.2	8,427	8,245	7,952	7,559
Increase or decrease over previous year number . . .	..	+99.8	+124.6	..	-182	-293	-393
per cent. . .	..	+13.4	+14.8	..	-2.2	-3.6	-5.2
				millions			
United States . .	3,315	3,616	3,940	6.10	5.55	4.99	4.37
Increase or decrease over previous year number . . .	..	+301	+324	..	-0.55	-0.56	-0.62
per cent. . .	..	+9.1	+9.0	..	-9.0	-10.1	-12.4

Sources: FAO Yearbook of Statistics, 1952, and (for horses in 1952) national statistics or OEEC. For U.S.A.: *Agricultural Statistics*, U.S. Dept. of Agriculture.

General Note: Tractor numbers refer to tractors of over 8 h.p. This means that horticultural tractors are generally excluded. Data refer as far as possible to the position at the end of the year stated.

Horse numbers refer to horses of all ages. Mules and asses are excluded.

(a) Number in December of the previous year.

The pattern which emerges from a comparative analysis is that in the first phase tractors increase but horses remain steady (e.g. Austria, France, 1951); then tractors increase more rapidly and horses begin to decline (W. Germany, 1951)¹; then the increase in tractors slows down while the decline in horses gathers momentum (U.S.A., U.K.). It is too soon yet to say whether tractor numbers and horse numbers will finally become stabilized at a 'saturation-point' and an irreducible minimum respectively.

¹ In Germany the number of draught oxen has decreased more rapidly than the number of horses.

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An indication of the future trend in numbers of working horses is given by statistics of the age-composition of the total horse population. In Belgium, for example, the total number of horses fell by 16 per cent. between 1950 and 1952, but the number of horses of from 1 to 3 years old fell by 35 per cent.

Where mechanization is in its early stages, relatively very few tractors are found on small or medium-sized farms, i.e. under

TABLE 2. *Number of tractors owned per 100 holdings, by size of holding*

	5-10 ha.	10-20 ha.	20-30 ha.	30-50 ha.	50-100 ha.	100 ha. and over	All hold- ings of over 5 ha.
Germany (Fed. Re- public)							
May 1949 . . .	1.9	6.3	26.9		76.8	181.5	8.9
April 1952 . . .	8.1	24.7	59.2		150.4		23.7
Netherlands							
December 1950 . . .	2.3	5.6	19.7	54.5	124.2	493.6	11.0
Norway							
June 1949 . . .	3.4	18.0	65.8		124.9	227.0	12.5
Sweden							
June 1944 . . .	0.8	3.9	20.1	49.9	85.1	150.2	10.4
June 1952 . . .	..	..	..	..	..	..	28
		10-15 ha.	15-30 ha.	30-60 ha.	60-120 ha.	120 ha. and over	All hold- ings of over 10 ha.
Denmark							
July 1950 . . .	..	2.5	8.6	30.7	73.2	223.5	15.3
	6-12 ha.	12-20 ha.	20-40 ha.	40-81 ha.	81-101 ha.	101 ha. and over	All hold- ings of over 6 ha.
Ireland							
June 1949 . . .	0.9	1.6	4.5	13.9	25.8	38.9	4.2
	6-12 ha.	12-20 ha.	20-40 ha.	40-61 ha.	61-121 ha.	121 ha. and over	All hold- ings of over 6 ha.
England and Wales							
January 1950 . . .	40.6	60.6	91.4	132.9	200.7	389.0	114.9

Sources:

Germany: *Wirtschaft und Statistik*, Sept. 1951 and May 1953.

Netherlands: *Landbouwtelling*, 1950.

Norway: *Statistisk Årbok*, 1951.

Sweden: *Jordbruksräkningen, År 1944 and Jordbruksekonomiska Meddelanden*, Mar. 1953.

Denmark: *Statistisk Årbog*, 1951.

Ireland: *Irish Trade Journal and Statistical Bulletin*, Sept. 1952.

England and Wales: *Agriculture* (Journal of Ministry of Agriculture), Aug. 1951.

50 hectares (Ireland, 1949); but the process extends rapidly downwards from the larger farms, and before long the point is reached when more than half of the medium-sized farms have tractors (Netherlands, 1950). At this stage between 80 and 90 per cent. of the farms of over 50 ha. will have tractors, and many will have more than one each. Later still the position may be reached—in 1950 it had already been reached in England and Wales—where the majority of the smaller farms of from 5 to 20 ha. each possesses a tractor (Table 2).

During the intermediate and later phases of mechanization the number of tractors on the larger farms continues to increase, but at a much slower rate than on the smaller farms (Table 3).

TABLE 3. *Rate of increase in tractor numbers, by size of holding*

Germany (Fed. Rep.)		Sweden (a)		England and Wales	
Size of holding (ha.)	Percentage increase in tractors, April 1951 to April 1952	Size of holding (ha.)	Percentage increase in tractors, June 1951 to June 1952	Size of holding (ha.)	Percentage increase in tractors, March 1950 to March 1951
5-10	59.3	2-10	56.4	Under 20	15.3
10-20	49.4	10-20	35.0	20-61	9.5
20-50	28.9	20-50	9.2	61-121	7.0
50 and over	15.1	50 and over	6.5	Over 121	6.2

Sources:

Germany: *Wirtschaft und Statistik*, May 1953.

Sweden: *Jordbruksekonomiska Meddelanden*, Mar. 1953.

England and Wales: *National Farmers' Union Information Service*, Feb. 1953.

(a) Southern highlands and eastern and western lowlands.

The average horse-power per tractor increases with the size of holding (Netherlands, 1950), many of the smaller holdings employing tractors of horticultural types. On holdings possessing two or more tractors their average horse-power is generally less than when only one is owned. This suggests that the second tractor bought is generally of smaller horse-power than the first (Table 4).

The relation between tractors and horses is not a simple one of substitution or displacement. There are more horses on large farms than on medium and small farms, even where mechanization has reached a fairly advanced stage. In Germany and the Netherlands, at least up to 1950, holdings using tractors kept nearly as

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many horses as those of comparable size but without tractors (Tables 5 and 6).

TABLE 4. *Average horse-power per tractor in the Netherlands in 1950, by size of holding and number of tractors owned*

Size of holding (ha.)	Number of tractors owned			
	1	2	3	4 or more
	<i>h.p.</i>	<i>h.p.</i>	<i>h.p.</i>	<i>h.p.</i>
Under 5	8	7	7	6
5-10	16	11	8	12
10-20	22	17	14	15
20-30	24	21	20	20
30-50	26	25	23	18
50-100	29	28	27	23
100 and over	33	30	29	37

Source: Landbouwtelling, 1950.

TABLE 5. *Average number of horses per holding, by size of holding*

Size of holding (ha.)	Germany (Fed. Rep.) May 1949(a)	Netherlands 1950(b)	Denmark July 1949(c)	Norway June 1949(a)
5-7½	0.5	1.0	1.9	1.2
7½-10	0.9			1.6
10-15	1.4			2.1
15-20	2.0	2.2	3.4	3.3
20-30	2.6			
30-50	3.6			
50-75	4.9	4.4	5.1(d)	5.6
75-100	6.1			
100-150	7.7			
150-200	9.6	10.9	14.3(f)	10.0
200 and over	17.2			

(a) Horses 3 years old and over.

(b) Working horses.

(c) Horses of all ages.

(d) 30-60 ha.

(e) 60-120 ha.

(f) 120-240 ha.

Sources: As Table 2.

The eventual reduction in horse numbers makes possible a substantial economy in land, since it is generally held that at least one hectare of land is required to feed one horse. For this reason the retention on farms of horses which work at very much less than their full capacity for most of the year represents a serious waste of land—perhaps as much as 5 per cent. of the total area of a small or medium-sized farm.

TABLE 6. *Draught animals on holdings with and without tractors*

Size of holding (ha.)	Germany: Fed. Rep. (1949)		Netherlands (1950)	
	Draught animal units per 100 ha. on holdings		Working horses per 100 ha. on holdings	
	Possessing a tractor	Not possessing a tractor	Using mechanical draught power	Not using mechanical draught power
Under 5	17.3	23.0	10.9	13.1
5-10	16.3	21.8	12.6	13.4
10-20	12.5	16.2	10.2	10.8
20-30	10.2	12.0	8.7	9.4
30-50			8.2	8.9
50-100	8.4	8.2	7.1	6.7
100 and over	7.0	2.7	2.9	1.4

*Sources:*Germany: *Wirtschaft und Statistik*, Sept. 1951.Netherlands: *Landbouwtelling*, 1950.*Labour on medium-sized farms*

More important than the saving in animal power and in land which may result from mechanization is its effect on the productivity per unit of labour employed, since it is the level of productivity of labour which largely determines agricultural incomes.

A farmer might raise labour productivity by (i) cultivating more land with the same labour force, i.e. extending the boundaries of his farm, (ii) maintaining the present level of production on the same area but with a reduced labour force, or (iii) adopting a more intensive system of farming without increasing the labour force. For social and political reasons the first solution is unlikely to be practicable in many cases; the number of farms cannot easily or quickly be reduced. The economics of mechanization has therefore to be considered in the context of the other two solutions.

The use of machinery to enable a farmer and his helpers to work fewer hours while maintaining the same amount of production will raise productivity *per man-hour* worked in agriculture, but it will not affect labour productivity *over the whole year* unless the hours saved are put to other employment. Either more work has to be created on the farm—which means the intensification of production, the third solution mentioned above—or else the individuals concerned have to find supplementary employment outside agriculture.

Where the number of workers employed is not more than three or

four, the total discharge of one person may not be possible without some contraction in the total activity of the farm, which would normally be an undesirable development from the point of view of the national economy. The alternative course of finding part-time work outside agriculture presents difficulties in most rural areas. In considering the economics of mechanization of medium-sized farms it is therefore of vital importance to consider the typical structure of the labour force on such farms (Table 7).

TABLE 7. *Average labour force per holding, by size of holding*

Size of holding (ha.)	Germany (Fed. Rep.), 1949 persons regularly employed		Netherlands 1950 man-years		Belgium 1949 man-years		Ireland 1949 males	
	number	per cent. family workers	number	per cent. family workers	number	per cent. family workers	number	per cent. family workers
5-10	3.84	..	2.08	90	2.08	93	1.2(a)	89
10-15			2.75	80	2.33		1.4(b)	88
15-20					2.79		1.6(c)	82
20-30	5.55	62	3.65	62	..	..	..	..
30-50	7.08	46	5.36	38	..	..	2.0(d)	68
50-75	10.30	28	8.83	20	..	..	2.7(e)	50
75-100	15.22	16			..	..	..	..

Sources:

Germany: *Wirtschaft und Statistik*, July 1950.

Netherlands: *Landbouwtelling*, 1950.

Belgium: *Études de la Petite Exploitation Agricole, II. Le Travail*, by A. G. Baptist and H. Waterschoot.

Ireland: Agricultural Census, 1949.

(a) 6-10 ha. (b) 10-12 ha. (c) 12-20 ha. (d) 20-40 ha. (e) 40-81 ha.

On farms of from 20 to 30 ha. family labour predominates. A fairly typical pattern would appear to be: farmer (full-time); his wife (part-time); an adult son or brother of the farmer (full-time); a hired man (full-time); and a boy or girl or another hired worker (often part-time or seasonal)—between three and four 'man-years' in all. In many cases, to dispense entirely with the help of one member of a team like this will be a radical operation affecting the whole system of production, because the introduction of labour-saving machinery will only eliminate or reduce *some* of that member's daily tasks.

On farms of from 30 to 50 ha. there is often, in addition to the team described above, a second hired man (or woman) or a second son, and it is here that any economy of labour is likely to fall. Studies made in

the Netherlands and Belgium¹ indicate that many farms of from 20 to 30 ha. cannot be expected to give full economic employment to a second son in addition to the 'social minimum' (i.e. the smallest number of persons required to keep the family farm in existence) consisting of the farmer and his wife and their immediate successor;² and the same would apply, no doubt, to some farms of from 30 to 50 ha. More sons of farmers should go straight from school to non-agricultural occupations.

A study in Belgium compared actual labour supply on individual farms of under 20 ha. with theoretical labour requirements for those farms, calculated on the basis of 'standard' hours per unit of crops grown and livestock kept, plus 15 per cent. for maintenance work, &c. For the size-group 15 to 20 ha. there was on the average an apparent labour 'surplus' of 22 per cent. (The surplus was greater in the smaller size-groups.) The holdings with the highest labour efficiency did not have appreciably more work-units in the form of crops and livestock, but they employed much less labour than the average of 2.79 man-years per farm.

It would be useful to have further studies of labour supplies in relation to labour requirements on medium-sized farms in a number of countries. To obtain the highest value from such studies, the methods of calculating 'man-years' and standard work-units should be as uniform as possible. Meanwhile it appears that, at least under some systems of farming found in Europe, holdings of from 20 to 30 ha. on which more than 3 man-units per year are engaged (with adjustments to this figure as size of holding increases) should probably view mechanization primarily as a means to reducing the labour requirement. On holdings of 20 to 30 ha. with less than 3 man-units engaged, machinery should generally be directed towards increasing total production (e.g. by the growing of more fodder crops for cattle, pigs, and poultry, obtaining higher grassland yields, better conservation of green crops, keeping more cows, &c.).

¹ *Het Kleine-Boeren Vraagstuk op de Zandgronden*. Landbouw-Economisch Instituut. A. G. Baptist and H. Waterschoot, *Études de la Petite Exploitation Agricole, II. Le Travail*.

² Many farmers' sons marry farmers' daughters, and the concept of the 'social minimum' should allow for this; but it is not a *necessary* condition for the perpetuation of family farms.