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EAST OF SCOTLAND COLLEGE OF AGRICULTURE

ECONOMICS DEPARTMENT

# DEVELOPMENTS IN POTATO HARVESTING

## - Electronic and self-propelled harvesters

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Developments in Potato Harvesting

A study of electronic and self-propelled  
potato harvesters operating in  
S.E. Scotland in 1969.

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## FOREWORD

The substantial gains in labour productivity in agriculture have only been made possible by the introduction of new or improved machinery and as the labour force diminishes, the continuance of certain enterprises depends entirely on the success of further mechanisation. Inevitably the task facing agricultural engineers becomes more formidable and the complexity of machines necessitates larger and more costly development programmes.

For the farmer under pressure to mechanise, there is the ultimate prospect of lower-cost production, but only at the expense of large capital outlays and a consequent increase in overhead costs. Hence, as machines become available, there is a growing demand for objective assessments of performance and operating costs under field conditions to be made as soon as possible, in order to assist investment decisions.

This report is perhaps unique in that it considers the performance of two new types of potato harvester, both of which incorporate major technical developments, in the first full year of commercial operation.

Obviously the significance of the data presented is limited by the fact that they relate to one year's operation of a relatively small number of machines carrying out a task that is particularly vulnerable to variations in climatic conditions. These limitations are taken into account in the report and allowance is also made for improvements that can reasonably be expected as a result of the experience gained in the first year.

It is considered that early publication of this information will be of benefit both to farmers who are currently faced with the problem of lifting large acreages of potatoes and to those likely to meet it within the next few years. More representative information will become available after the 1970 harvest, but in the meanwhile it is hoped that this report will provide an initial assessment of these new developments.

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## INTRODUCTION

During the period from 1955 to 1965, the acreage of potatoes grown in Scotland fluctuated from 125,000 to 140,000 acres. From 1966 onwards however, there was a steady decline to 95,000 acres in 1969, although provisional estimates suggest a slight increase in 1970.

The decline in acreage has been associated with a proportionately greater fall in the number of producers, particularly since 1965. Those continuing with the enterprise have tended to specialise, the average acreage grown having risen from 9.4 acres per producer in 1956 to 15.8 acres in 1968. The share of the total acreage grown by producers with 50 acres or more has risen by 16% to 41%, as shown in Table 1.

TABLE 1: Number and percentage of producers in Scotland related to the percentage of acreage grown - 1956 and 1968.

Acreage per producer	1956			1968		
	No. of producers: '000	%	% of acreage grown	No. of producers: '000	%	% of acreage grown
Under 10 acres	10.1	74	23	4.1	59	12
10 - 30 acres	2.5	18	32	1.7	25	26
30 - 50 acres	.7	5	20	.6	9	21
Over 50 acres	.4	3	25	.5	7	41
Totals	13.7	100	100	6.9	100	100

Source: Potato Marketing Board

Note: The number of producers excludes the number making nil returns. The percentages of acreages grown exclude acreages for which returns were not available when the figures were compiled.

The trend towards specialisation in potato production has been accompanied by a decline in the availability of casual labour and hence greater pressure has been placed on producers to substitute machinery for the traditional squads employed for harvesting. However, it is only during the last 5 or 6 years that development of the complete harvester has reached the stage of offering a practical alternative to hand work. Fourteen years ago there were only 73 complete harvesters on Scottish farms, but by 1967 the most recent year for which information is available, there were more than 1,000 machines (Table 2).

TABLE 2 : Trends in lifting equipment - 1956 to 1967

Implement	1956		1964		1967	
	No.	%	No.	%	No.	%
Spinners	16316	85	15407	78	14014	76
Elevator and shaker diggers	2848	15	3455	18	3459	19
Complete harvesters	73	...	733	4	1003	5
Totals	19237	100	19595	100	18476	100

Source: D.A.F.S. machinery censuses.

Note: The table shows the number of implements owned as distinct from being in use. Many of the spinners and some of the elevator diggers can be regarded as stand-by units.

### Harvesting problems

Despite the continuing development of complete harvesters, the problems of lifting the potato crop remain basically the same. The time available for the operation is determined by the date of maturity of the crop, weather conditions during the lifting period and the demands of other enterprises for labour and machinery. Ideally the crop should be ready to spray down by late August for seed and early September for maincrop ware. This allows time for a two or three week ripening period before lifting starts. Harvest work should then be completed well before the weather breaks towards the end of October, the crop being stored under good conditions which permit rapid healing of the inevitable damage arising from the lifting operation. In practice, the length of the harvest period is to a large extent pre-determined by the height of the land above sea level, although choice of variety, chitting some of the seed and growing a mixture of seed and ware crops can all help to increase the time available for the operation.

The introduction of complete harvesters whilst reducing the dependence on casual labour for lifting the crop, tends to make soil and weather conditions more critical and, because of the slower rate of work often achieved, may result in a longer harvest period with repercussions on other enterprises. Greater care in seedbed cultivations and summer work is also desirable in order to reduce the problem of clods at lifting time.

In Scotland, an added complication is the inability of most complete harvesters to work satisfactorily in the stony and hilly conditions which are frequently encountered. Hence in many situations, there has been little practical alternative to the use of squad labour.

THE SURVEY

The 1969 season was notable for the introduction of two new potato harvesters; one, a fully automatic machine requiring, at most, only two people to work it, and the other, the first self-propelled machine to be used in this country. The automatic harvester employs the electronic/pneumatic system for separating potatoes from clods and stones which was developed at the Scottish Station of the N.I.A.E. The self-propelled machine is basically a conventional harvester but has its own power unit and incorporates a hopper of 10 cwt capacity, allowing some work to be done without a trailer in attendance.

Eight electronic harvesters and 5 self-propelled machines - all that could be traced in the east of Scotland - were visited during the harvest period and detailed work measurement and damage assessments were carried out at the time of the visits. In addition detailed records were kept by co-operators for 30 crops lifted by 6 of the electronic harvesters and for 23 crops lifted by 4 of the self-propelled machines. These records included hours worked, breakdowns and other lost time, soil and weather conditions, together with information regarding the impact of these machines on individual farm systems.

Table 3 gives an indication of the type of farm using these harvesters in 1969. Almost all the co-operators were growing a substantial acreage of potatoes, mainly for seed. Seven electronic machines lifted 508 acres, while 299 acres were lifted by 5 self-propelled units.



TABLE 3 : General information relating to the farms in the sample

Farm	Acreages				No. of full-time regular workers <sup>1</sup> on the farm
	Total	Arable	Potatoes	Potatoes lifted by harvester	
<u>ELECTRONIC</u>					
EH 1	Merchant	-	270	107 <sup>2</sup>	n.a.
" 2	350	300	210 <sup>3</sup>	60	12
" 3	1169	797	90	65	12
" 4	440	370	68	61 <sup>4</sup>	7
" 6	800	640	80	80	8
" 7	660	570	150	74	6
" 9	570	450	70	61	3
Total	-	-	938	508	-
Average	665	521	134	73	8
<u>SELF-PROPELLED</u>					
SPH 1	724	643	72	39	15
" 2	262	160	32	30	4
" 3	830	774	96	90	5
" 4	Merchant	-	200	85	n.a.
" 5	273	208	55	55	4
Total	-	-	455	299	-
Average	522	446	91	60	7

<sup>1</sup> Excludes dairymen

<sup>2</sup> Two shifts regularly worked by this machine

<sup>3</sup> Includes rented land

<sup>4</sup> A further 15 acres were lifted on contract.

### Lifting period

The 1969 harvest period was notable for an exceptional run of fine weather. Three of the electronic harvesters worked for 7 to 9 weeks starting at the beginning of September and finishing at the end of October or early November. The remainder worked a more typical lifting period of 5 to 6 weeks as did the self-propelled machines. All of the latter finished work at the normal time or earlier for the farms concerned. Only 5 of the electronic harvesters completed the harvest in the normal period, the remaining two machines finishing later than would normally be expected despite the generally excellent weather conditions.

### Organisation

The electronic harvester required a large tractor of at least 60 h.p.; in four cases, 70 h.p. models were used for harvesting on steeper land. The self-propelled model was generally powered by tractor units of around 45 h.p., although in the one case, the power unit was changed for one with slightly more power\*.

Under normal conditions a team of 4-5 men were sufficient to operate the electronic machine, cart and store the crop. In one case a two shift system was operated for most of the season, working for about 15 hours per day, while one other machine was worked for a shorter period of time by two teams. Where only one team was available, 10 hours was about the maximum which could be sustained for any length of time. Work usually proceeded for 7 days a week, weather permitting.

The self-propelled model was dependent on a labour team of three casuals plus one regular worker on the harvester, together with the driver, two men carting and one in the store - a total of eight. Weekend working was more limited as a result of having to find casuals - one farmer employed a second team for this purpose - but more typically, an 8 hour day was worked for 6 days a week.

In most cases, for both machines two trailers were normally sufficient for distances up to about a mile from the store.

The introduction of the self-propelled harvesters did not make much difference to the general organisation on the farms concerned. However, on three farms where electronic machines replaced two conventional harvesters, thereby reducing the regular labour commitment for the harvesting operation, greater flexibility of working had resulted. In two cases other work on the farm had been delayed by the harvest taking longer than normal. Where the shift system had been introduced, no trouble had been experienced in getting the men to work the hours required.

\* Gear ratios have been modified on the 1970 harvester.

Performance

A. Electronic harvester

The overall rates of work are given in Table 4. There was little difference between the average times calculated from the field records and those observed in the field at the time of visits.

TABLE 4 : Rates of work

Code No.	Acreage <sup>1</sup> recorded	Rate of work <sup>2</sup>	
		Field records: acres/hour	Observations: acres/hour
EH 1	107	.28	.24
" 2	51	.23	.26
" 3	56	.26	.35 1st visit .17 2nd visit
" 4	76	.35	.45 1st visit .32 2nd visit
" 5	-	-	.32
" 6	62	.35	.32
" 7	30	.35	.34
" 9	-	-	.30
Average	64	.30	.31

<sup>1</sup> In some cases records were not kept for the full acreage lifted by these harvesters.

<sup>2</sup> Inclusive of breakdowns and turns, but excluding all meals.

The range in average rates of work conceals a wider range from field to field for each harvester. The precise reasons for the range are more difficult to determine. Analyses on the basis of yield or soil type, do little to explain the differences. (Table 5).