MACHINERY COSTS ON TILLAGE FARMS AND THE DEVELOPMENT OF DECISION SUPPORT SYSTEMS FOR MACHINERY INVESTMENT/USE ON FARMS

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Teagasc acknowledges the support of Cereals Levy Farmer Funds in the financing of this project

ISBN 1 84170 070 3

September 1999

Teagasc
The Science of Farming and Food

EUROPEAN UNION
European Agricultural Guidance and Guarantee Fund

Teagasc, 19 Sandymount Avenue, Dublin 4

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SUMMARY

Costs and benefits associated with the use of farm machinery are difficult to calculate. A research programme was established to highlight the area of machinery costs and to provide information on which to base mechanisation decisions.

A machinery cost survey was the central part of the programme which collected detailed machinery cost information from 40 arable farms over a period of three years. Costing methods were developed to provide an annual per-hectare cost for each machine over its ownership period. An average annual machinery cost figure of £194/ha, excluding labour, was recorded. Costs varied from £93/ha to £340/ha between farms. Depreciation and interest accounted for almost 60% of the total costs figure.

Larger farms (>160 ha) had lower costs and less cost variation than smaller- and medium-sized farms. They were more machinery efficient, with lower levels of machinery investment per hectare. Smaller- and medium-sized farms had much greater cost variation with many farms being over-mechanised, resulting in excessive machinery costs. The importance of selecting an appropriate mechanisation policy for individual farm situations was evident.

Using information from the survey to select appropriate costing methodology from other research, a simple cost-prediction computer program was developed. This allows costs for an individual machine at any use level to be estimated. This program was used to evaluate various mechanisation options on 40, 100 and 240 ha farms. The program was then redeveloped for use by the advisory service. It is a decision-support type program which requires input from a trained operator with experience of mechanisation. It should prove useful in determining farm mechanisation policies against a background of changing mechanisation technology, farm labour supply and potential price-support reductions.

INTRODUCTION

Machinery represents an important input in crop production, with substantial costs and benefits associated with its use. Despite its high cost, machinery has not received the same level of critical attention as other inputs. Machinery costs are difficult to calculate and present in a meaningful form. Similarly the benefits associated with machinery use are difficult to quantify in monetary terms.

The study reported here was established to highlight the need for more rational machinery investment and use on tillage farms, and to generate information which would allow mechanisation policies on Irish farms to be selected using a cost/benefit approach.

OBJECTIVES OF THE STUDY

The objectives of the study on machinery costs were to:

1. Collect detailed machinery cost information from a number of tillage farms.

2. Analyse the machinery cost components (depreciation, interest, repairs etc.).

3. Review existing costing methodology and research from other sources.

4. Establish methodology for determining the optimum level of machinery investment on farms.

METHODS

Establishing machinery cost survey

The central part of this project was the establishment of a detailed machinery cost survey. A total of 40 farms were included in the survey. The participants were selected by Teagasc tillage advisers in counties Tipperary, Wexford, Kilkenny and Meath. The counties were selected to give a range of farm sizes, soil types and farming practices. The participants did not represent a random sample but were

selected to give a wide range of machinery systems, operating scales and approaches to investment and use of machinery.

Data collection

Machinery cost information was collected during annual visits to the participating farms. Detailed baseline information was established on the initial visit. The information was collected under the two headings 'farm details' and 'machine details' outlined below:

Farm details	Machine details
Farm size	Machine type
Land rented	Model and specification
Enterprise size	Age
Cropping	New or second-hand
Labour	Condition
Contractor use	Use level
Machinery practices	Replacement age
Maintenance/repair policy	Finance details
	Repair history

The participating farms recorded details of all machinery-related transactions for a period of three years. The repairs and maintenance costs were recorded on an individual machine basis. Recording diaries were checked and collected on an annual basis.

Analysis of survey data

The objective of the analysis was to produce an equivalent annual cost-per-hectare figure for each machine owned on each of the farms. The individual machine cost figure was derived from the calculated depreciation, interest and repair cost components. The entire cost analysis was carried out on a PC-type computer using a specifically-developed spreadsheet program.

Standard depreciation methods used in tax accounting are frequently not suitable for estimating real depreciation rates. Second-hand machines, very long ownership periods and low use levels cause particular problems. True depreciation is what it costs the farmer to replace a machine with a similar specification machine, allowing

for inflation. Predicting the residual value of a machine is a key component of this system. As there is no up-to-date source of residual value information, residual values using information from the retail machinery trade were used. An example of a depreciation calculation is given in Table 1. Inflation is taken into account by using current values rather than historic or future values.

Table 1: Example of machinery cost calculation

Eg. 55 kW 4WD tractor, bought new, replaced at 5 years

(a) Depreciation:	'Cash' price:	£27,000		
	Residual value:	£12,000		
	Annual depreciation:	(£27,000 - £12,000)/5		£3,000
(b) Interest:	Borrowed £15,000 for 5 years:	Annual charge	£1,050	
	Owned £12,000	Annual charge	£300	£1,350
(c) Repairs & maintenance:	Standard maintenance:		£300	
	Repairs:		£750	
				£1,050
	Total annual cost:			£5,400

The second machinery cost component, interest, must be charged on money invested in a machine, whether the money is borrowed, owned or a combination of both. There are many different methods of calculating interest. Frequently, all capital is costed at the same rate for the entire life of the machine, e.g. a rate of 12% on the average value of the machine over its ownership period. In practice, on many farms, borrowed capital is used to finance just part of the machine purchase for a short term. The remainder of the capital is sourced from the farm's own resources. In this study, interest was calculated based on its source, i.e. the individual finance arrangements for each machine were taken into account, e.g. how much was borrowed and for what term.

The repairs and maintenance figure used was based on three years' recorded data on the participant farms. Routine maintenance (e.g. servicing), routine replacement (e.g.

tyres), and non-routine repairs were included. Both the labour and parts content of off-farm repairs were included. Where repairs/maintenance was carried out by farm personnel, a labour charge was not included as it was not possible to get reliable records on many of the farms.

The total farm machinery cost figure was generated by adding together the costs of all the individual machines. Other costs, which were not collected on an individual machine basis, such as fuel, insurance and workshop equipment, were also included at this stage. Farm labour associated with both the operation and maintenance of machines was not included, as reliable records were not available.

Evaluation of costing methods

Machinery cost research is time-consuming and expensive because of the quantity of research data required to overcome the inherent variability of the subject and to cater for the range of machine types and use patterns in existence.

Research literature dealing with machinery costs was reviewed to determine the usefulness of the data and methodology used as a basis for determining machinery costs on Irish farms. In addition, a number of machinery cost computer programs were examined to determine their usefulness.

Development of a costing program

Machinery selection decisions are complex as there is a wide range of options which can be considered in each situation. Accurate cost prediction, where costs can be predicted for any size and type of machine at any use level, is an essential part of any machine selection program. Sufficient data would not be available from the cost survey to generate accurate cost prediction formulae for the range of tillage equipment available. Information from the cost survey was used to select and modify costing methods sourced from the literature review to develop a simple decision support system for Irish farms.

SURVEY RESULTS

Description of surveyed farms

Some 40 individual tillage farms were included in the survey. Detailed cost information on individual machines was recorded on these farms. The size of the tillage enterprise operated on the farms surveyed varied from 22 ha to 445 ha, with most farms having 40 to 80 ha of tillage. About 50% of the participants were renting land for tillage (either con-acre or share farming). Almost 40% of the farms visited had tillage as their sole enterprise.

The regions where the surveyed farms were located influenced the cereal cropping pattern (e.g. spring vs winter cereals). Farms growing exclusively winter cereals were primarily located in counties Meath and Kilkenny. Counties Tipperary and Wexford had a large proportion of growers with only spring cereals. All regions had some growers with winter and spring cereals.

Break crops (constituting more than 10% of tillage area) were used in rotation on 55% of the farms. Sugar beet was the most popular break crop and is of significance in machinery costings, as the seeding and harvesting equipment is different from that used in cereal production. Oilseed rape and linseed were also grown on some of the farms.

In the case of cereal production on the surveyed farms, most of the work from sowing to harvesting was carried out using the farm's own machinery (>88%). Straw baling was the exception, as straw was frequently sold before baling. Harvesting machinery was owned on 80% and beet seeders on 50% of surveyed farms where sugar beet was grown.

The type of equipment, its age and replacement policy varied greatly between the farms.

Average machinery costs

Full cost analysis was carried out on 37 of the 40 farms surveyed. Three were excluded because of incomplete data. The average annual machinery cost per

hectare figure was £194.22 (Table 2) for all operations from ploughing through to harvesting. Of particular note, however, was the wide range of costs recorded, which varied from a low of £93/ha to a high of £340/ha. Grain drying, straw baling and operating labour or farm labour used to maintain/repair machinery are not included. The costs outlined include VAT. To put these costs in perspective; if a contractor was used to perform all the machinery operations on a winter-cereal-producing farm, a charge of £230/ha would be typical. Taking into account that the contractor is also supplying labour, it is clear that the mechanisation policies on many farms warrant attention. In particular, the range of costs encountered in the survey clearly indicates that machinery costs and the factors influencing them require detailed examination.

Depreciation and interest

The machinery cost components are also shown in Table 2. Depreciation is the largest single cost component. Depreciation in this study is based on a machine valuation method, as the survey was not of sufficient duration to allow recording of individual machine purchase and sale figures.

Table 2: Annual machinery costs per hectare on all surveyed farms

Total machinery costs/hectare	Average (£/ha)		Range (£/ha)
	194.22		93 – 340
Depreciation	79.86	(41%)	25 – 176
Interest	31.90	(17%)	8 – 78
Repairs	41.41	(21%)	17 – 84
Diesel	20.13	(10%)	14 – 31
Other	20.92	(11%)	-

Depreciation and interest together account for almost 60% of the total machinery cost figure. This is at variance with many farmers perceptions, as the constant flow of repair and fuel bills is more noticeable than a less frequent machine purchase. Typically, depreciation and interest costs are 'hidden' in machinery repayments, which may only occur for a certain proportion of the machine's life, e.g. 3 years out of a machine life of 8 years. The analysis used in this study gives a constant annual depreciation cost.

Repair costs

Repair costs averaged £41.41 (21%) over the surveyed farms. There was a lot of variation in repair costs, both between farms and between the years of the survey on individual farms. Three categories of repair/maintenance costs were evident in the data. Routine maintenance, such as tractor servicing, accounted for a consistent annual cost on most farms. The replacement of soil-engaging parts was also a routine operation. Machine breakdowns were much less predictable on all farms. The cause of many of the breakdowns may also have been component wear, but in complex machines, consequential damage to components other than the immediately worn part was quite common.

Fuel and other costs

Fuel costs showed a considerable degree of variation between farms. Variations in cropping, the distance between areas farmed and soil type were responsible for most of the variation.

The other cost category included items such as insurance, tax, miscellaneous repairs, workshop equipment etc. Where contractors were used, their cost was also included.

Effect of farm size

The farms surveyed were divided into three categories: small (<60 ha); medium (60-160 ha) and large (>160 ha). Larger farms in the survey had lower costs (average £159/ha) (Table 3). The difference in average machinery costs between large- and medium-size farms was £18/ha. Small farms (<60 ha) had substantially higher costs at £54/ha more than the medium-sized category.

The variation in machinery costs within the size categories differed. The range of machinery costs recorded on the large category farms showed least variation. The smaller- and medium-sized categories had substantially more variation (30-50%).

Table 3: Machinery costs and farm size

	Average farm size (ha)	Machinery costs	
		Average (£/ha)	Range (£/ha)
Large (>160 ha)	267	159.06	129 - 178
Medium (60 - 160 ha)	93	177.12	91 – 269
Small (<60 ha)	42	230.96	161 - 338

It is useful to look at some of the characteristics of these farms (Table 4). Economies of scale were clearly evident in some of the parameters given in this table. Although total machinery investment was greater on the larger farms, the average value of the machines owned per hectare farmed was much higher on smaller farms (£1,033/ha vs £618/ha and £491/ha).

Table 4: Machinery characteristics of different sized farms

	Large (>160 ha)	Medium (60-160 ha)	Small (<60 ha)
Average farm size (ha)	267.2	92.6	42.3
Machine value (£/ha)	491	618	1033
Tractor value (£/ha)	179	244	485
Tractor power (kW/ha)	1.3	2.0	4.3
Tractor number/farm (no.)	3.2	2.4	2.3
Mean age of primary tractor (yr)	4.3	7.1	8.2
Non-tillage work for tractors (% of total work)	22	48	65
Nominal cultivation and sowing workrate (ha/hr)[1]	2.0	1.5	1.17

[1] potential workrate based on size of implements

The level of capital invested in tractors showed similar trends to overall investment, with small farms having twice as much invested per hectare compared to medium farms and almost 3 times as much as large farms. The number of tractors owned and the power supplied showed further differences between farms. While the tractors

operated on the larger farms were more powerful, when expressed on a per hectare basis, the average power input on these farms at 1.3 kW/ha was only 30% of the small farm group. The larger farms usually purchased new tractors, however, and replaced them quite frequently.

Interestingly, the nominal cultivation and sowing capacity of the equipment operated on the large farms was not much greater than that used on smaller- and medium-sized farms.

Overall, the larger farms in the group were very machinery efficient, operating modern high-capacity equipment with low labour requirement and little breakdown time. Machinery repairs on these farms were frequently carried out, off the farm, by machinery suppliers.

Medium-sized farms in the survey attempted to control costs by keeping machines on the farm for longer and by using second-hand machinery. This group had more tractors, more power and more cultivation/sowing capacity per hectare than the larger farm groups. This is partly explained by the use of second-hand machinery, where large-capacity machines are often considered better value and where a relatively high workrate can guard against timeliness losses in the event of a breakdown.

The small farms in the group had a much higher machinery investment per hectare than the other groups. On these farms, the availability of other work for machines, such as grassland enterprise or some contracting, is an important feature in keeping costs competitive.

Variation within farm size categories

There was considerable variation in total machinery costs between farms within the small- and medium-size categories. To determine the cause of this variation, farms in these groups were categorised as either 'high' or 'low' cost (i.e. above or below the average cost figure) and some of their results were analysed separately (Table 5). The data used in this table is from the 1993 survey results. This analysis showed that all the cost components: depreciation, interest and repairs were higher on the 'high-cost' farms.

Table 5: Characteristics of above-average and below-average cost farms in the

medium and small farm size groups (1993 data)

	Medium 60-160 ha		Small <60 ha	
	Above-average costs	Below-average costs	Above-average costs	Below-average costs
Total cost (£/ha)	200	136	279	183
Depreciation + interest (£/ha)	127	77	178	108
Repairs (£/ha)	47	31	58	41
Mean tractor age	5.2	8.9	7.3	8.7
Tractor value (£/ha)	316	242	850	383
Adjusted value* (£/ha)	240	168	469	250
Power (kW/ha)	2.0	1.9	4.8	3.1

* adjusted: tractor value/acre adjusted for the total work the tractor does, including grassland enterprises, contracting etc.

On the low-cost farms, most repairs were carried out on the farm, either using the farm's own labour, or occasionally using mobile repair services. It was a feature of low-cost farms in both these groups that the farmer was often skilled in selecting good second-hand machines and was capable of maintaining/repairing machines inexpensively using farm labour.

Implications of survey results

The costing survey results clearly indicated the need to improve decision-making concerning machinery at farm level. Most mechanisation strategies on farms are inherited, i.e. machines are often owned or replaced simply because they always were. However, farm machinery has changed, in terms of output capacity, technological development and cost. Because of this development, mechanisation strategies on farms need to be changed. Lack of information has hindered this change.

It is clear from the survey that decisions about machinery are complex. There are no

simple calculations or rules of thumb which will determine complete mechanisation strategies for all farms. Each farm situation differs. The provision of a decision support system, which would allow various mechanisation options to be evaluated for an individual farm, offers the best scope for improving decision-making at farm level.

EVALUATION OF COSTING METHODOLOGY

Research and methodology review

A review of costing methodology and computer programs was carried out. A number of research papers were reviewed to determine the suitability of the cost-prediction methodology used, for Irish farms. Components of the methodology used in some of the papers (Witney[1], Williams[2], Turner[3], Morris[4], ASAE[5]) were considered suitable for incorporation in a decision support-type program. Some of the existing computer programs examined were easy to use and were visually impressive with good presentation. However, the methods used within these programs to calculate machinery costs were not satisfactory. The program 'COST' (Silsoe Research Institute) is probably the best machinery cost application. It uses the discounted cash flow technique to calculate annual machine running costs, but the repairs and depreciation formulae used are based on very old research data.

DEVELOPMENT OF A COSTING PROGRAM

Computer program

A simple spreadsheet program, which uses cost prediction equations from four different sources, was developed. The costing equations used were modified to improve their accuracy when dealing with low annual-use levels and second-hand machines. The program was set up to predict the operating costs of 10 different machine categories (e.g. ploughs, tractors etc.). It was used initially to predict cost information for 600 different machine type/use combinations. Assessment of the methodology used was carried out by comparing the predicted costs of operating machinery on a small number of farms in the cost survey with the costs recorded from the survey. The program was then used to evaluate mechanisation options in

three different farm situations.

Evaluation of mechanisation options

In developing a mechanisation policy for an individual farm, decisions have to be taken at a number of different levels, i.e. whether to own machinery or use a contractor, what mix of machines to own, type and capacity of machines, replacement cycle length and other factors. The availability of a decision support program, which allows the user to evaluate various options, is probably the most practical approach to machine selection.

The costing program developed in this project can be used in this way. As an example, the costs associated with different mechanisation options on 40, 100 and 240 ha tillage farms were determined.

For each of these farms, machines were selected which would allow each operation to be carried out without timeliness penalties. Options considered included: the use of extended machine replacement cycles; use of second-hand machines; reduction in the number of machines and use of contractors. It should be noted that this is just an example of how the costing program can be used. Individual situations are examined. It is not a definitive statement of the best mechanisation policy on all farms of the sizes selected.

Predicted costs: 40 ha

The initial mechanisation strategy, which included ownership of all machines, costed for this farm is detailed in Table 6. Machine types, replacement cycles and use levels are outlined in this table, as well as the predicted annual costs calculated by the program. Where conventional cultivation equipment was costed, annual machine costs of £256/ha were recorded. When a one-pass (3 m pto-powered) cultivation sowing system was included, costs were increased to £285/ha. The costs associated with this alternative are shown in brackets and italics in Table 6. Machine use levels on this farm are very low. The farm is over-mechanised.

Table 6: Machinery costs on a 40 ha farm with a full machinery complement

Machine	New/SH	Life[1] (yr)	Annual use (hr)	Annual cost (£/ha)	
Cultivations					
a. Plough 3F Rev.	N	15	68	22.59	
b. Cult. 3.6 m	N	15	27	7.37	
c. Roller 4 m	N	15	15	7.50	
d. Drill 3 m	N	15	23	13.06	50.52
One-pass 3 m	*(N)*	*(15)*	*(32)*	*(38.18)*	*(68.27)*
(replacing b, d)					
Sprayer etc.					
Sprayer 12 m	N	8	38	9.94	
Spreader 12 m	N	8	17	5.42	15.36
Combine etc.					
Combine	SH	6-15[2]	38	75.90	
(4 straw walker)					
Trailers (2)	N	15	30	12.00	
Miscellaneous[3]				6.00	93.90
Tractors					
a. 60 kW 4WD	N	15	150	54.49	
b. 52 kW 2WD	SH	10-20	100	18.05	72.54
82 kW 4WD	*(N)*	*(15)*		*(70.00)*	*(88.05)*
(replacing a)					
Fuel, labour					
Fuel				15.00	
Casual labour				8.20	23.20
Casual labour				*(4.75)*	*(19.75)*
(one-pass)					
Total costs					
Conventional					255.52
One-pass					*(285.33)*

[1] Replacement cycle [2] 6-15; bought at 6 years, sold at 15 years [3] Dual wheels etc.

An alternative machinery strategy, using mainly second-hand machinery, was assessed (Table 7). In this table, the savings that accrue to changes in particular machines are indicated. Allowing for slightly increased repair costs, this strategy gave a net saving of £68/ha. The disadvantage of this option is that there are a lot of machines to be maintained on a relatively small farm.

Table 7: Cost savings using second-hand machines: 40 ha

Machines	Saving (£)	
Cultivations machinery: 6-15 year cycle	9.32	
Sprayer etc.: 15-year cycle	2.98	
Combine: 10-20 year cycle	25.18	
Trailers + misc.: 10-20 year cycle	6.00	
Tractor: 60 kW 2WD, 6-15 year cycle	24.02	
Saving	67.50	
Total machine cost (£/ha)		188.02

The third option costed (Table 8) assessed the effect of eliminating the second tractor, the combine and casual labour. As ploughing and cultivation/sowing would now be carried out at separate times, a less-expensive conventional plough was substituted for the original reversible plough. To maintain the ability to operate as a one-man unit, a 2.5 m wide compact harrow-type drill combination was costed. This system allows the farmer to retain good control of his operations, while shedding casual labour and two old machines (tractor and combine). Allowing for the introduction of a contractor charge, the total costs for this system were predicted to be £172/ha.

Table 8: Cost savings using one tractor: 40 ha

Machines	Saving (£)	
One-way 3F plough (new)	7.18	
2.5 m non-powered one-pass (new)	-4.59	
Less combine	50.72	
Less 52 kW S/H tractor	18.05	
Less fuel + casual labour + misc	13.20	
Contractor combine charge	-69.00	
Saving	15.56	
Total machine cost (£/ha)		172.46

More extensive use of contractors is a realistic option on farms of this size (Table 9). Minimising investment in machinery by operating just a tractor, fertilizer spreader, sprayer and one trailer, resulted in a total predicted cost of £205/ha. Contracting for all operations would cost approximately £225/ha.

Table 9: Effect of extending contractor use: 40 ha

	Costs		
	Own machinery (£/ha)	Contractor (£/ha)	Total (£/ha)
Combine, till, sow	71.73	109	180.73
All except spraying and spreading	33.93	171	204.93
All operations	-	225	225.00

Predicted costs: 100 ha

A similar cost prediction exercise was carried out on a 100 ha farm. The initial mechanisation strategy costed for this farm is detailed in Table 10.

Table 10: Machinery costs on a 100 ha farm with a full machinery complement

Machine	New /SH	Life (yr)	Annual use (hr)	Annual cost (£/ha)	
Cultivations					
a. Plough 4F Rev.	N	8	127	16.35	
b. Cult. 3.6 m	N	5	67	6.07	
c. Roller 6.0 m	N	15	21	4.55	
d. Drill 4 m	N	8	36	10.20	37.17
One-pass 3 m (replacing b, d)	*(N)*	*(8)*	*(80)*	*(22.24)*	*(43.14)*
Sprayer etc.					
Sprayer 18 m	N	8	53	10.41	
Spreader 18 m	N	8	28	4.00	14.41
Combine etc.					
Combine (4 straw walker)	SH	6-15[1]	95	39.95	
Trailers (2)	N	15	70	8.00	
Miscellaneous				5.00	52.95
Tractors					
a. 82 kW 4WD	N	15	200	32.26	
b. 67 kW 4WD	N	15	200	24.61	
c. 60 kW 2WD	SH	6-15	100	10.99	67.86
82 kW 4WD (replacing b)	*(N)*	*(15)*		*(32.26)*	*(75.51)*
Fuel, labour					
Fuel				15.00	
Casual labour				11.45	26.45
Casual labour (one-pass)				*(8.75)*	*(23.75)*
Total costs					
Conventional					198.84
One-pass					*(209.76)*

[1] 6-15; bought at 6 years, sold at 15 years

As with the 40 ha farm, annual tractor use was extremely low, being less than 500 hr in total.

Using second-hand tractors and extending the replacement cycle on some of the other machines substantially reduced operating costs (Table 11) to £166/ha (£176 using one-pass). The option of using a contractor to plough, while using a one-pass sowing system, reduced costs by from £2 to £16/ha, depending on whether a second-hand tractor/long machine life or new tractor/short life policy is used. Alternatively, the farmer could retain ploughing and get a contractor to till/sow with a similar effect on costs.

It was possible to achieve more substantial benefits on this farm by increasing the amount of work available for the remaining large tractor and cultivation/sowing unit.

Table 11: Options to reduce costs on a 100 ha tillage farm

			Saving (£)	
Option 1:	Extend machine life			
	Cultivations machinery: 15 year cycle		7.28	
	Tractors: All second-hand		22.84	
	Other machines		2.94	
	Saving		33.06	
	Total costs -	conventional system		165.78
		(£/ha)		
		(One-pass)		*(176.11)*
Option 2:	Use one-pass system			
	but using contractor to plough			
	Less 82 kW 4WD tractor		32.26	
	Less 4F rev. plough		16.35	
	Less fuel + labour		9.40	
	Additional tractor costs		-2.25	
	Contractor charge		-40.00	
	Saving		15.76	
	Total costs	- short machine life		194.00
		- long machine life		(173.88)

Predicted costs: 240 ha

On very large farms, because of better utilisation of machines, there is less scope for cost reduction. However, a small improvement in per hectare costs can make a substantial impact on farm profits. In the example selected, cultivation costs were quite high (Table 12). The combined annual use of the three tractors on this farm is unlikely to exceed 1,000 hr. This offers some scope for cost reduction where extending life reduces per hectare costs by over £8 (Table 13). Using a non-powered one-pass cultivator drill (e.g. Simba Top-Tilth etc.) offers scope for cost reduction and increased output. Even on this size of farm, the prudent use of a contractor can result in lower machinery costs.

Table 12: Typical machinery complements, operating hours and costs on a 240 ha cereal farm

Machine	New /SH	Life (yr)	Annual use (hr)	Annual cost (£/ha)	
Cultivation					
Plough 6F Rev.	N	8	210	20.05	
Roller 6 m	N	15	50	1.98	
One-pass 3 m	N	6	190	14.11	36.14
Sprayer etc.					
Spreader 24 m	N	8	50	3.51	
Sprayer 24 m	N	8	81	13.55	17.06
Combine etc.					
Combine (5 straw walker)	N	15	142	43.19	
Trailers (3)	N	15	140	5.00	
Miscellaneous				4.00	52.19
Tractors					
104 kW 4WD	N	15	300	18.94	
90 kW 4WD	N	8	500	21.70	
67 kW 2WD	N	15	200	8.49	49.13
Fuel, labour					
Fuel				15.00	
Casual operating labour				15.00	30.00
Total costs					184.52

Table 13: Cost reduction options on a 240 ha tillage farm

	Saving (£)	
Option 1: Extend machine life		
Plough life to 15 years	1.64	
90 kW 4WD to 15 years	3.79	
Use S/H 67 kW tractor	2.96	
Saving	8.39	
Total machine cost (£/ha)		176.13
Option 2: Use non-powered one-pass		
3 m 'Simba type' one-pass	5.03	
Casual labour reduction	1.50	
Saving	6.53	
Total machine cost (£/ha)		169.60
Option 3: Use contractor for ploughing		
Tractor saving	18.94	
Plough saving	18.41	
Casual labour + fuel saving	9.78	
Increase tractor costs	-1.27	
Contractor charge	-40.00	
Saving	5.86	
Total machine cost (£/ha)		163.74

This costing exercise highlights the complex interacting factors which influence an individual farm's machinery costs. It illustrates the benefit of decision support type programs, where the operator uses his own knowledge to input and assess realistic options for individual farms.

Development of program for advisory service

The ability of the spreadsheet program to evaluate machinery options prompted the development of a user-friendly version for use by tillage advisers. The objectives of this program were to:

1. Calculate individual machine costs using parameters such as machine type, use level, age at purchase and replacement etc.
2. Determine whole-farm machinery costs.
3. Allow the person inputting the data to adjust parameters and evaluate alternative mechanisation options.
4. Store machinery cost information in database form for subsequent analysis.

The program was developed in Access, a programmable database package which has sufficient capacity to carry out the necessary calculations, while providing a user-friendly interface. All inputted and calculated information is stored in a retrievable database. The program contains three distinct sections: 1) INPUT where farm and individual machine data is entered.; 2) CALCULATIONS where costing calculations are carried out; and 3) REPORTS where screen and printed results outputs are available. Many of the inputted variables can be easily changed to evaluate the effect of changes on subsequent costs and cost components. The program uses similar formulae and calculation routines to the spreadsheet version developed at an earlier stage. The operator can effectively adjust some of the calculations where reliable machine or farm information is available.

The program is intended for use by a trained user who has sufficient knowledge of the program and of farm mechanisation to ensure realistic options are evaluated. Use of the program would require the farmer to have available information on all machines on the farm, in addition to farm cropping etc. Following the establishment of current costings, viable alternatives can then be examined.

An early version of the program was evaluated by 6 advisers and changes/modifications that they requested were incorporated in the first finished version. A training programme, for Teagasc tillage advisers, in the use of the software was carried out.

FUTURE MECHANISATION

While this project focused on machinery costs, their calculation and prediction, it also allowed the future of mechanisation on tillage farms to be considered. The following points are worth noting:

- There is a need to examine mechanisation policies on all farms to determine if cost savings can be made.

- Mechanisation decisions need to be carefully planned because of the long-term nature of machinery investment on most farms.

- Mechanisation technology continues to develop, offering potentially better cost-effective machines. The best method of deploying this technology (which

requires scale) on all farm sizes needs to be determined.

- With more part-time farmers and a shortage of agricultural labour envisaged, the issue of labour and machinery use needs to be examined.

- The role of alternatives to single-farm ownership of machines, such as partnerships, rings, contractor use etc. need to be determined.

- The concept of an individual specialising in a machinery operation and offering that service across a number of farms has potential to be a cost and labour efficient means of supplying mechanisation needs.

- Because of the complex nature of mechanisation decisions, assistance, in the form of decision support type programs, is needed to provide specific solutions for individual farms.

CONCLUSIONS

- Machinery costs on tillage farms are substantial, with an average annual figure of £194/ha recorded excluding farm labour. Costs varied from £93 to £340 per ha.

- The wide range of costs encountered indicates the scope for cost reduction on many farms.

- Larger farms tended to have lower costs and less cost variation than smaller farms. They utilised modern machinery efficiently.

- The selection of an appropriate mechanisation policy (owned vs contractor, type of machine, replacement policy etc.) is essential, particularly on smaller- and medium-sized farms.

- A review of existing costing methodology revealed shortcomings for use on Irish farms.

- Information from the survey allowed the most suitable costing methods to be

incorporated in a computer program designed to aid decision making about machinery.

- The program effectively allows mechanisation options to be evaluated on individual farms.

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